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AN INTEGRATED AUTOSAMPLING GAS CHROMATOGRAPHIC/DATA SYSTEM FOR REPETITIVE ANALYSIS OF CW AGENT VAPOUR IN PENETRATION/DESORPTION EXAMINATIONS

by

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ABSTRACT

An automated system utilizing two Varian gas chromatographs, a Varian 401 Chromatography Data System, and an Apple II^+ computer has been developed to perform repetitive analysis for Chemical Warfare agent vapours or other target vapours either penetrating through or desorbing from materials. Single-, or simultaneous dual-detector analysis of target vapours in effluent gas streams from one or two vapour sources can be performed by use of a heated multiport gas sampling valve. Software for the storage of vapour analysis results on the stand-alone microcomputer has been developed. As well, programs for post-run selection and storage of quantitative results of specific components based on retention time, output of tabular summaries of the selected component concentration with elapsed time and graphical display and hardcopy of the concentration-elapsed time profiles are described. Subsequent analysis of liquid extracts of the material for residual agent is accomplished on the second dual-detector gas chromatograph equipped with autosampler. The design of a desorption cell for use with the system is also given and an example of the utility of the system employing Malathion is described.

RÉSUMÉ

Un système automatisé utilisant deux chromatographes en phase gazeuse Varian, un système de traitement de données chromatographiques Varian 401, et un ordinateur Apple II^+ a été mis au point pour doser de façon répétitive des vapeurs des agents utilisés comme armes chimiques et d'autres vapeurs cibles pénétrant dans des matériaux ou se désorbant de ceux-ci. L'utilisation d'une vanne d'échantillonnage chauffée à chambres d'injection multiples permet de doser les vapeurs cibles dans l'effluent gazeux d'une ou de deux sources de vapeurs, par analyse avec un seul détecteur ou par analyses simultanées à l'aide de deux détecteurs. Le système est doté d'un logiciel permettant de stocker les résultats d'analyse sur le micro-ordinateur autonome; il possède aussi des programmes permettant de sélectionner et de stocker après analyse des résultats quantitatifs sur des constituants spécifiques, basés sur le temps de rétention, de restituer sous forme de tableaux des récapitulatifs donnant la concentration de certains constituants en fonction du temps écoulé, et d'afficher et de restituer sur papier des graphiques donnant des profils concentration-temps écoulé. Les dosages ultérieurs des agents résiduels dans les extraits liquides sont réalisés avec le second chromatographe gazeux à deux détecteurs muni d'un auto-échantillonneur. On donne également la conception de la cellule destinee à être utilisée avec le système et on illustre l'utilité du système à l'aide de malathion.

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1.0 INTRODUCTION

In chemical defence as well as other areas of research there is often a need to examine the penetration of vapours through, or the desorption of an absorbed compound from certain types of material. These measurements can then be employed to characterize the resistance to penetration, the adsorptive/desorptive capacity and the decontaminability of these materials upon exposure to various chemical compounds. Of particular concern to the CF is the study of the desorption of Chemical Warfare (CW) agent vapours from protective clothing following their contamination. Research into more effective means of decontaminating material such as protective clothing raises questions as to the level of threat which could be posed by desorption during the hot-air drying of incompletely-decontaminated protective material. Such studies can then be employed in the development of superior clothing decontamination materials and procedures to avoid secondary contamination during drying and to reduce the hazards presented to laundering personnel and to subsequent wearers of the garments.

In the past, entrainment bubblers have been used for the collection of vapours desorbing from or penetrating through materials [1]. In these systems, inert gas or air was passed over the surface of the material mounted in a closed cell arrangement and through the bubblers containing typically 5 mL of a relatively involatile organic solvent such as diethylsuccinate or diethylphthalate. Aliquots were then taken from the bubblers at various times and analysed for the concentration of CW agent accumulated [1].

Analysis can be carried out by Gas Chromatograph (GC) or by colorimetric means. Although the entrainment solvent approach has been used extensively, there are several drawbacks. In the case of the analysis by GC, the advantage that all the agent is being collected is counterbalanced by the fact that only uL quantities of solution can be injected compared to the 5 mL quantities used. Colorimetric approaches employ greater quantities of the solution and thus lower detection limits can be achieved by this method. The major disadvantage with these approaches is that they are labour-intensive, especially the colorimetric methods. While these methods can provide results for the cumulative amounts of agent desorbed or penetrating over a period of time, as dictated by a specification for example, definition of the profile of the desorption or penetration over the duration of the examination is limited by the number of aliquots which can be physically removed and analysed.

In some applications, it is important to know how the desorption or penetration proceeded with time. For instance, if an agent was found to penetrate through a material by slowly increasing over time as opposed to suddenly breaking through, then different conclusions as to the utility of the material might be drawn depending on the toxicities of the agent and the required application of the material, e.g. if sudden breakthrough occurred after a period of time then the material could be usable for short term protection. In addition, profiles of agent penetration or desorption could be further used to test models for the penetration or absorption processes which eventually could lead to an understanding of the factors determining resistance to penetration and of the mechanism of penetration.

In the case of hot-air drying, if a sample of material is slowly heated and the profile of desorbing agent is examined, maximum temperatures above which considerable desorption occurs could be determined to avoid high levels of secondary contamination from occurring. Such thresholds could be very important if, for example, it was found that degradation of the remaining agent was taking place at lower temperatures.

A system based on single- or dual-detector Varian gas chromatographs has been developed which permits automated repetitive analysis of CW agent or other target material vapour in a carrier gas stream from one or two sample desorption cells. The generated data, stored on an Apple computer, is subsequently searched for the components of interest on the basis of their retention times. Tables of target compound concentration as a function of elapsed time during the desorption or penetration examination are provided as well as the capability to graphically present the results.

2.0 EXPERIMENTAL

2.1 Hardware and Instrumentation

A schematic diagram of the layout of the instrumental hardware of the system is given in Figure 1. Arrows indicate the direction of flow of data or control information.

2.1.1 Computer/Data Systems

The system relies on the Varian VISTA 401 Gas Chromatographic Data System for operational control of two gas chromatographs and auxiliary equipment (liquid autosampler and gas switching valves) and for all data collection and quantitation. Storage of data for subsequent manipulation and recalculation for analyses of liquid samples is also achieved with the VISTA 401 Data System. Because of the limitation to two channels of stored data (disc drives) on the VISTA 401 Data Systsem, an Apple II^+ system with monitor, dual disc drives and dot-matrix printer is utilized with communication between the two data systems being achieved by an Apple High Speed Serial Interface Card and appropriate software marketed by Varian Associates under the name of Vista Plus. In order to provide permanent hardcopy of the detector responses from the vapour-sampling gas chromatograph an additional Varian remote printer-plotter driven by the VISTA 401 Data System is employed.

2.1.2 Gas Chromatographic (GC) Systems

GC analysis of liquid samples is performed on a Varian Model 4600 Gas Chromatograph equipped with Varian Dual Flame Photometric (FPD) and Flame Ionization (FID) detectors, a glass column (6 ft x 0.25 in OD) packed with 3.5% OV-17 on 80/100 mesh Chromosorb 750 and an all-glass 50/50 effluent splitter. Although a packed column is employed in this application, the newer Megabore (J&W Scientific Inc.) columns with appropriate injector and effluent splitter systems could easily be substituted. Helium carrier gas is employed. Injections are effected using a Varian Model 8000 Autosampler adjusted to deliver one-uL samples. Conditions for analysis are adjusted to suit the components being analysed. For examining the quantities of CW

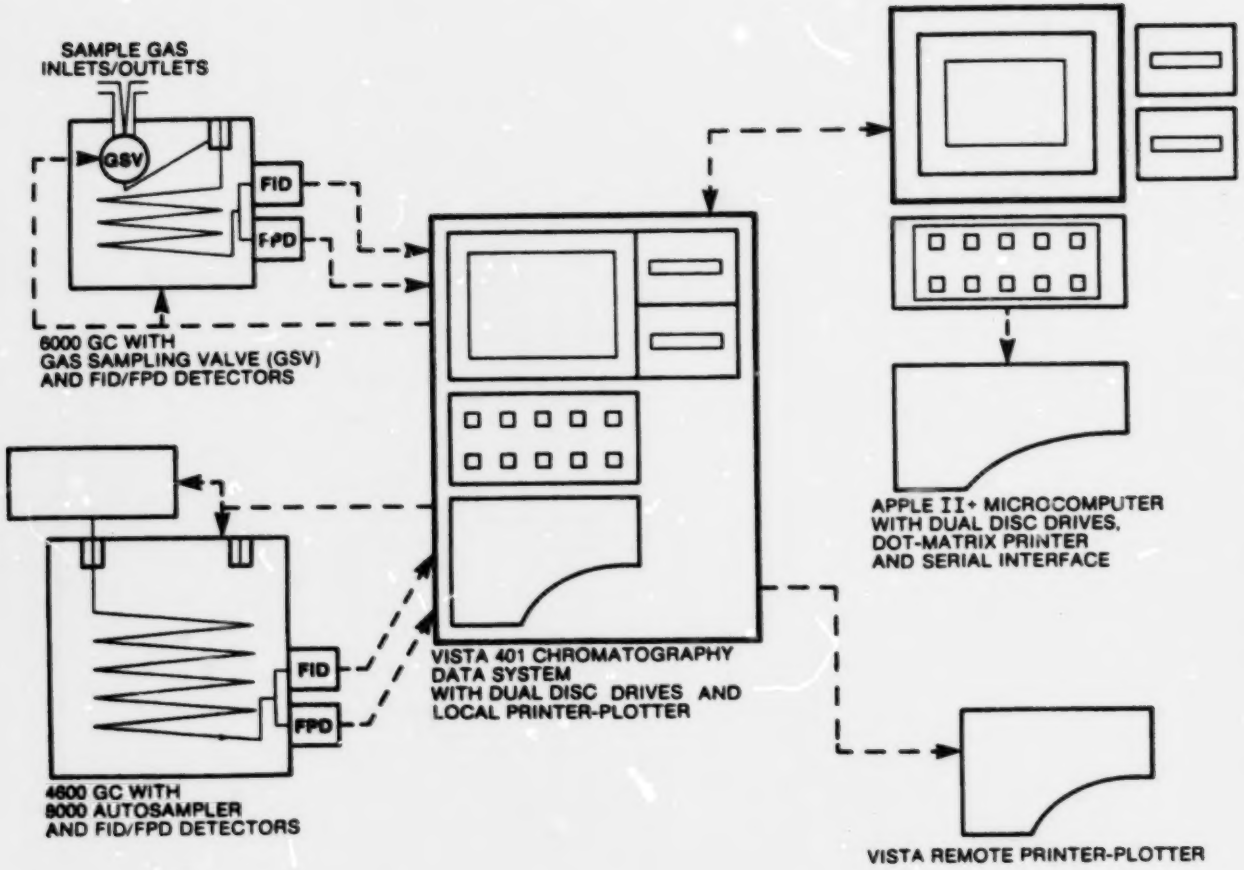


Figure 1. SCHEMATIC CONFIGURATION OF ANALYTICAL AND COMPUTATIONAL INSTRUMENTATION.

agents desorbed from clothing material, the solvent is, typically, diethylsuccinate and operational conditions are adjusted to provide adequate separation of the solvent and its impurities and from the components of interest.

GC analysis of components in the gas streams is carried out on a Varian Model 6000 Gas Chromatograph equipped with Varian FPD and FID detectors, a similar glass column packed with 3.5% OV-17 on 80/100 mesh Chromosorb 750 and an all-glass 50/50 effluent splitter. Nitrogen is employed in the vapour analysis both as the GC carrier gas and as the desorption carrier gas to transport the target material to the GC for analysis. By employing nitrogen for both flows, injection-related phenomena are kept to a minimum. The chromatograph is equipped with a 10-port gas sampling valve (Valco) controlled by the VISTA 401 Data System through the 6000 GC and operated by solenoid-controlled compressed air (Figure 2). The valve is installed inside one of the GC's injector blocks with two 1-mL stainless steel injection loops coiled to fit into the heated zone of the injector and four stainless steel 1/8 in. Swagelok ports protruding from the injector block for connection to sampling lines. The plumbing of the 10-port valve is configured to permit sampling of two separate gas streams by separate injection loops so that one loop is in the carrier gas stream of the GC while the other is in line with the flow from its respective vapour source. Desorbed vapour of the stream being analysed flows through a bypass in the valve when the respective sampling loop is in line to the GC column.

2.1.3 Desorption System

In the present application, the system is designed for determination of CW agent vapour evolving from contaminated Chemical-Biological (CB) protective materials, bare/coated metal or plastic surfaces. This is achieved by measuring permeation through or desorption from the material following application of liquid agent to establish the material's absorptive properties or the effectiveness of a decontamination or contamination control procedure or formulation. To achieve this end, the material being examined must be enclosed in an air-tight cell and an inert gas such as nitrogen passed through the cell to transport the agent to the gas sampling valve.

Various views of the cell used in the study of CB clothing material are shown in Figure 3. The cell is composed of two parts. The base unit incorporates inlet and outlet ports for the desorption carrier gas and an O-ring groove to seat a sealing O-ring. The cover unit contains a shallow cavity to permit passage of carrier gas up through the test material, across the top surface and down through the material on the exit outlet side. Three bolts are used to hold the halves together and the holes are machined with corresponding slots on the outside surface to secure the boltheads from turning as the nuts are being tightened. A second set of holes is included to permit the use of two base units, as top and bottom, thus producing a single cell which has inlets and outlets both above and below the material. Generally however, a complete cell consists of a base and a cover unit bolted together. In many applications, the cell components would be fabricated from stainless steel. However, if

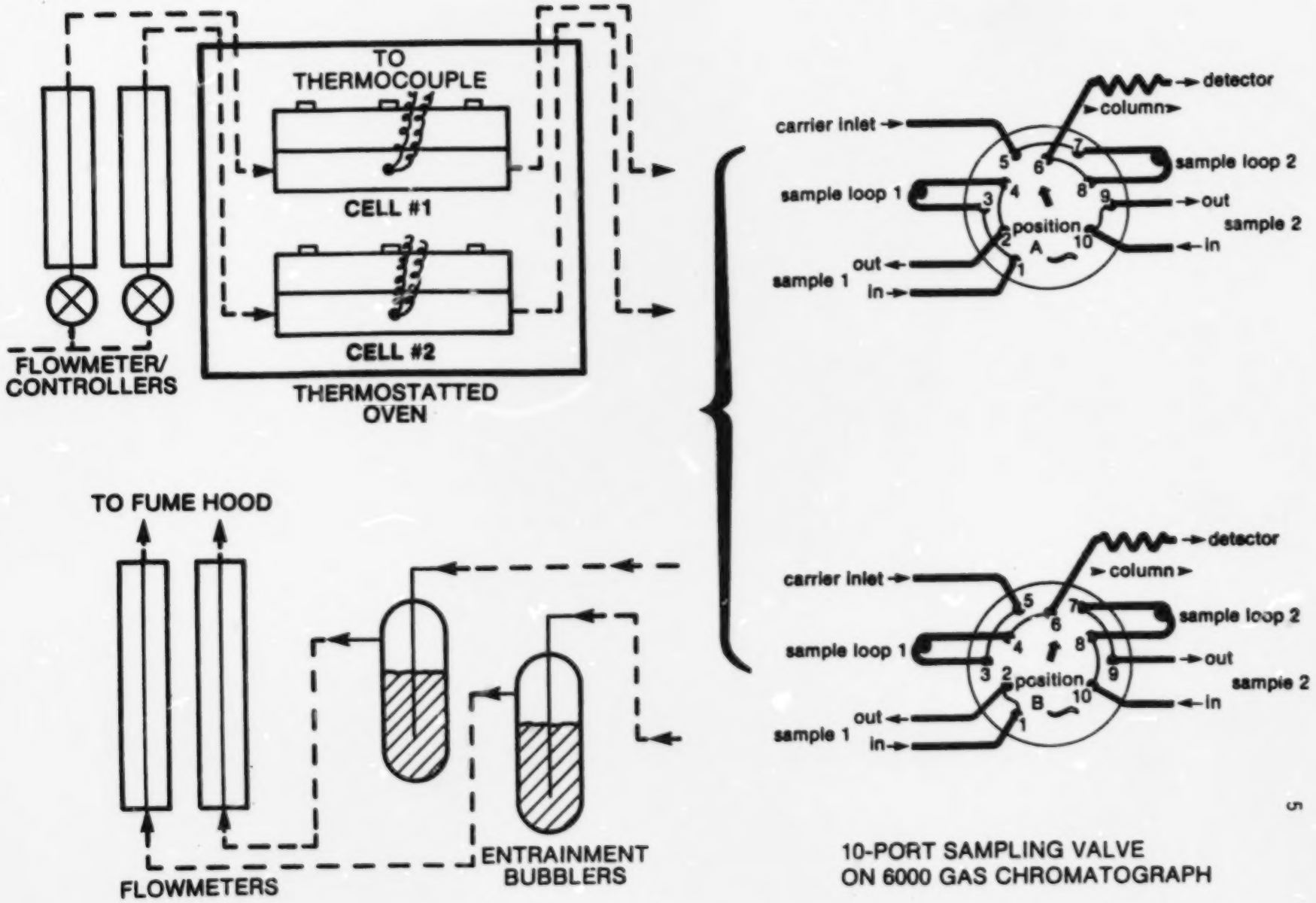


Figure 2. SCHEMATIC OF VAPOUR-SAMPLING APPARATUS.

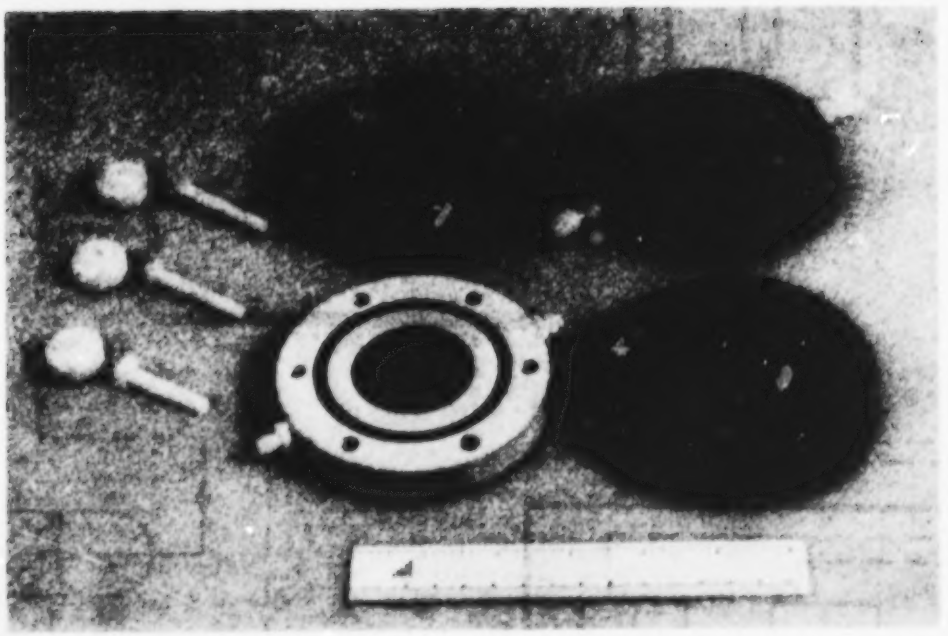


Figure 3. FLOW-THROUGH DESORPTION CELL.

absorption of the analyte(s) could possibly be a factor, the cells may be machined from Teflon or other similar material.

Incoming flows of carrier gas to each base unit are controlled by flow meters equipped with needle valves (Figure 2). Sampling from each of the two base units, either as top and bottom of the same cell, or as bases of separate control and sample cells is then carried out. Carrier gas lines, made of inert Teflon tubing and maintained at elevated temperatures with heating tape to reduce adsorption of semi-volatile compounds, conduct the mixtures of carrier gas and desorbed vapour from the cells to the multiport sampling valve. Exhaust flows from the valve are conducted through similar lines to separate glass bubblers containing diethylsuccinate for collection of semi-volatile compounds. From the bubblers, the carrier gases are passed through two additional flowmeters. The flows registered by the second set of flowmeters serve as a safety measure to warn of minor leaks in the cells, connecting tubing or bubbler assemblies, which could go undetected by apparently normal flowrates through the bubblers.

The system can be used for any study requiring automatic repetitive analysis of one or more analyte vapours in two flowing gas streams and separate analysis of liquid samples for those or other compounds.

2.2 Analytical Approach

Calibration of a vapour-sampling GC is not as straightforward as for a liquid-sampling GC in which a vial with accurately-known concentrations of components in appropriate solvents can readily be used. Systems employing the permeation principle have been devised in which the vapour sources are small permeable tubes containing the target material held at constant temperature. Calibration is then achieved by switching the flow past the tube for a number of analyses, and calculating the appropriate calibration factors based on weight differences of the tube and knowledge of the desorption carrier gas flow rate. Although that principle could have been employed here as well, the required precision for the intended purpose and the added complexity dictated that simpler means be used. To achieve this, effluent from the gas-sampling valve mounted in one injection block is routed by way of 1/16 in. stainless steel lines and appropriate reducers to the inlet of a 1/4 in. on-column injector mounted in the other injector block of the Varian 6000 GC into which the glass column is inserted (Figure 1). Manual injection of the components of interest in a volatile solvent can then be made through this injector for purposes of calibration as well as optimization of oven temperature and other operational parameters. By using a volatile solvent, conditions close to those to be used for analysis of the component in an effluent gas stream can be used.

The desirability for automatic operation and for application to a wide range of potential target compounds and requirement for permanent storage and hardcopy of results dictated that specific software programs be developed. To reduce the number of data files to be stored and manipulated, a single analysis consists of the responses from both desorption cells, recorded consecutively. The response from the one base unit (or gas flow) is recorded and displayed in the first half of the chromatogram and the response from the second one in the last half of the same chromatogram. Integration by the VISTA 401 is carried out on the data

as though it is a single continual analysis. Since there are no solvents involved in the vapor analysis and switching from one cell to the other does not produce a significant effect on the detector baselines, reliable integration of invidual components can easily be achieved.

In general, both compound-specific (phosphorus or sulfur) FPD and universal FID detectors are employed to present a complete picture of the target compound and of any other organic material which may be desorbing from the sample. However, the software programs developed for this purpose are applicable to any type of detector and can be used with single- rather than dual-detection analysis as well.

In a typical analysis, programs for actuation of the gas-sampling valve, control of temperatures of the oven, injector and detectors and associated programs for integration in the two chromatographs are developed for the analyte(s) of interest by injecting known samples into the on-column injectors on the GCs. For the vapour-sampling GC, conditions for separation of the target compound from other desorbants and valve actuation times are required. For the other chromatograph, separation of the target analyte from the entrainment solvent and its impurities is necessary. Calibration factors for each detector on each chromatograph are then determined, samples are prepared and mounted in the desorption cells and appropriate flows of nitrogen established through the system into and through the entrainment bubblers.

Initialization of the VISTA Plus interface is performed and the first program VISTADSKSHORT is started with appropriately initialized data diskettes in the VISTA 401 and Apple II^+. Repetitive vapour-sampling on the 6000 GC is commenced and sampling carried out as long as is necessary. The progress of the analysis can be monitored on the VISTA 401 remote printer-plotter (as an example, see Fig. 4 (a)).

After completion of the vapour sampling, samples of the entrainment liquids in the two bubblers are transferred to autosampler vials, with appropriate dilution if necessary, for analysis on the 4600 GC. As the accumulated quantities of gas injected by the sampling loops (1 mL) are small compared to the total quantities of gas passing through the cells during an experiment, it is assumed that the bubbler contents represent the entire quantities of target compound evolved over the duration of the experiment (if vapour analysis is continued over the duration of the experiment, calculations can be carried out to verify that the integrated total of the 6000 GC vapour analyses from a particular cell is in agreement with the corresponding bubbler contents as determined by the 4600 GC). The analyses of the bubblers also provide the total quantities of compounds desorbing or penetrating in those investigations in which the GC analyses of the vapour evolving are not continued for the entire duration of the desorption such as, for example, in a study in which desorption-profile behaviour is not of interest after the accumulated amounts of vapour have exceeded some critical threshold value.

Finally, the data on the Apple II^+ system is manipulated to separate the response from each detector and each base unit by discrimination based on retention time windows. Tabular output of the concentration of target compound for each detector and each cell as a function of time elapsed from

the commencement of acquisition can be provided as well as graphical representations of the time-concentration behaviour in one or both cells. (An example of these outputs is given below for a typical analysis (Figs. 5-8)).

2.3 Software

The operation of the VISTA 401 Data System is covered in the instructions with the instrument [2] and will not be discussed here except for the responses to several commands used to transmit and receive data from the auxiliary Apple system. Description of the software used on the Apple system will be given in more detail since it involves some original programming to achieve proper storage of the data and subsequent manipulation of the results. Subroutines and subsections relating to the operation of the Vista Plus interface will not be discussed in detail since they are covered under copyright elsewhere [3].

2.3.1 The VISTA 401 Data System

The software for the Apple II$^+$ developed in this study is designed to cover a wide range of application. From the viewpoint of the VISTA 401, several options must be accomodated. For instance, the analysis may involve only one detector on the 6000 GC in which case a single-channel Method [2] on the VISTA 401 is employed. Alternatively, both detectors of the 6000 GC may be used and a dual-channel Method [2] on the VISTA 401 would be required. The Method of the more commonly-used detector (FID) is used as the control Method in which commands for actuation of the injection valve on the 6000 GC are incorporated (Section 4, Page 4, VISTA 401 Method file [2]). Another available option permits output from the Apple II$^+$ to be printed on the VISTA 401 remote printer-plotter. If this option is desired, the printer must be reserved in the two Methods (Section 7, Page 2, VISTA 401 Method file [2]).

Finally, the format of the data transmitted to the Apple II$^+$ must be noted (Section 7, Page 1, VISTA 401 Method file [2]). Since integration algorithms already exist in the VISTA 401, only the final report of the analysis is sent to the Apple II$^+$. Because of the structure of the VISTA interface software, more information is transmitted than is required. The programs for the Apple II$^+$ extract the necessary information and discard the rest.

2.3.2 The Apple II$^+$ Software

A brief description of each of the Apple II$^+$ programs will be given along with the inputs required. Complete listings and flowcharts of each program are given in the Appendices as generated by an application program entitled NAVIGATOR [4].

VISTADSKSHORT (Appendix 1)

This program operates the VISTA PLUS interface (after initialization using the VISTA PLUS INTERFACE program), receiving calculated results from and optionally sending information to the VISTA 401 Data System for output on the Remote Printer-Plotter and/or optionally printing results on the Apple printer. This program incorporates parts of the programs described

in the VISTA PLUS literature [3] as examples of the use of the data transfer routines (such as COMTRN, BASSUB) but is tailored specifically to receive reports from the VISTA 401 System. The required information is extracted from those transmissions, the relevant data is stored in consecutive data files on a DOS 3.3-formatted blank diskette in Disc Drive 2 in appropriate format (depending on single- or dual detection) and individual summaries are returned to the VISTA 401 System for output on the remote printer-plotter and/or directly to the Apple Dot Matrix printer/plotter. Initially it requires response to the following questions:

- Will the data result from a single-channel method (single detector) or a dual-channel method (both detectors)? For a single-channel method, the resulting data is stored under odd-numbered file names, e.g. CYCLE # 001, while for a dual-channel method, odd-numbered files result from the first detector and even-numbered files from the second detector. The calculated areas for all peaks are recorded which, in the case of an analysis from two cells, would include first those from one cell then those from the other cell.

- Will output to the VISTA 401 remote printer/plotter be required? Since the VISTA 401 already provides sufficient information on this printer during and following an analysis, this option would normally find use only in troubleshooting problems in data transmission.

- Will output to the Apple Dot Matrix printer/plotter be required? Although almost identical in format to the above output, this hardcopy is preferred since it does not involve transmission of information back to the VISTA 401 system and identifies each analysis by CYCLE number as well as time of analysis.

- The CYCLE number of the previous analysis is required. At the beginning of a set of analyses, the correct response is 0. Provided that no output back to the VISTA 401 remote printer/plotter is selected. Should there be a problem with diskettes, printer paper or a realisation that recording of the analysis results for a given period of time would provide little additional information, the Apple II^+ can be Reset and thus, permanent storage of results suspended. The resultant message on the VISTA 401 system is that there is "NO DATA SYSTEM ACK" for each succeeding cycle but the GC system and realtime output of chromatograms and calculated results of individual analyses will continue. When resumption of permanent data storage on diskette is required, the Apple program is restarted by a RUN command and the appropriate number of the last stored data file entered here. If a single detector is being used, the next odd number is automatically assigned to the next recorded analysis whereas for a dual-detector analysis, the next consecutive number is assigned. Although an interval of data has not been stored, there is no apparent break in the data files since the correct time will be recorded for the subsequent files and proper display of the results as a function of elapsed time from the beginning of the series will still be achieved.

Because of space limitations on the individual diskettes for dual-detector analyses, for those experiments in which more than 100 cycles are recorded (50 odd-numbered files for a single-detector or 100 consecutively-numbered files for the dual-detector option), provision is made to store the remaining analyses on a second initialized data diskette placed in the Disk Drive 1. Although the succeeding results are stored on the second diskette, the second program (VISTASUMMARY) automatically will examine both sets of results. By appropriate choice of length of analysis and use of suspended processing, the number of stored analyses can easily be confined to 200 cycles to capture the important behaviour of the components of interest.

VISTASUMMARY (Appendix 2)

The information stored in each cycle by VISTADSKSHORT includes the retention time and area count for every peak detected by the VISTA 401 which is, in turn, governed by the integration parameters selected for the analysis. In many applications, interest is focussed on the growth or disappearance of a single or perhaps two components. VISTASUMMARY is designed to permit selection of a single component for each detector and for each cell by examining a narrow window of retention times for each desired component. The selection can be different for each detector to observe the behaviour of one component not detectable by FPD and a second one which contains phosphorus or sulfur. The peak selected will be for the last detected peak occurring in the defined retention time range. With the precise control of temperature inherent in the VISTA series of GCs, sufficiently narrow ranges of retention time can be defined to isolate the component of interest. As discussed above, the same component evolving from the second cell can be isolated by selecting a retention time range equivalent to the duration of the analysis of the effluent from the first cell plus the retention time of the component of interest. Of course, some other component can be selected from the second cell if so desired. Initially it requests responses to the following questions:

- Is the analysis a dual-channel method, i.e. did it employ two detectors simultaneously?
- Were two cells used?
- What is the number of the final CYCLE recorded?
- What is the volume of the gas sampling loop (in mL)?
- What is the lower limit of the retention time range (in min) for cell #1?
- What is the upper limit of the retention time range (in min) for cell #1?

If the analysis involves both cells, two additional inputs for lower and upper limits for cell #2 are required, followed in either case by a request for the calibration factors in (counts/ng) for each detector.

The individual files (CYCLEs) are read one by one and for the appropriate peaks, exact retention times, analysis-start times and areas are stored in arrays, one for each cell. The results of these selections are recorded in two additional files, SUMMMARY #1 and SUMMARY #2, on the data disc in drive 2 and output is made to the Apple Dot Matrix printer/plotter. This output summarizes the behaviour of the component of choice by analysis number, retention time, digital area count, concentration (subject to calibration factors entered initially) and time elapsed from the beginning of the analysis series. If the analysis is a dual-channel method, the results of both detectors are printed in pairs for each analysis number; a second complete set is printed for the second cell if applicable.

VISTAPLOTFORM (Appendix 3)

For many applications, a simple listing of the concentration-time profile for the components may be sufficient. In other applications however, graphical representations of the data are preferred since fluctuations in concentrations and shapes of profile curves become more apparent. In still other applications, equations may be fitted to the concentration-time profiles to provide parameters which describe the overall behaviour in a more meaningful manner. This program recasts the results in a format recognizable and readable by software developed by Interactive Microware for curve fitting [5] or plotting [6]. The program requests responses to the following questions:

- What detector(s) were used? Because of the format used by VISTASUMMARY to store the results, it is necessary to specify which set of results from a dual-channel run is desired (FID or FPD) or if both sets are desired.

- Were both cells used? If so, the second file SUMMARY #2 will be read as well.

- Is there a requirement for a hard copy of the reformatted results? This output, on the Apple Dot Matrix printer/plotter, may be used to verify that the correct results are being generated or as a more compact summary of the concentration-time profile for each detector and each cell.

The program reads one or both SUMMARY files, reformats the data into a required style and records up to four files; FIDPC0, FIDPC1, FPDPC0 and FPDPC1 for detectors FID and FPD in cells 0 and 1. Although the listing in Appendix 3 leads to storage of the resulting files on disc 2 (statement #5230), it may be desireable to store these files on the diskette containing the CURVE FITTER or SCIENTIFIC PLOTTER-II program if those programs require further information from their own disk after reading the data files. A simple modification of D2 to D1 in statement #5230 facilitates recording the results on drive 1. Of course, the CURVE FITTER or SCIENTIFIC PLOTTER-II diskette would have to be placed in drive 1 before VISTAPLOTFORM is operated.

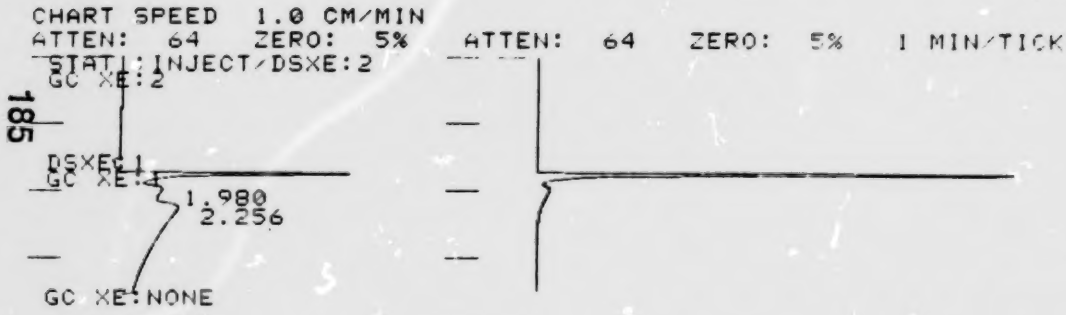
3.0 RESULTS AND DISCUSSION

To demonstrate the results which can be obtained using these programs and SCIENTIFIC PLOTTER-II, a small sample of Malathion (Qual Kit 52C, PolyScience Corporation) was placed on a microscope slide in one of the cells in the oven and the temperature of the oven slowly raised to increase the level of Malathion in the gas stream. Appropriate conditions for analysis of the vapour being carried out of the cell were established and a repetitive vapour analysis carried out. Calibration factors for the detectors towards this compound were not determined for this demonstration. As described above, calibration factors for each detector would be established for the target compound by injection of a known concentration into the liquid injector of the VISTA 6000 GC.

In one examination, both detectors were used to characterize the effluent from the cell. Several options were exercised; (1) consecutive recording of data files on the diskette with feedback to the VISTA remote printer/plotter and output to the Apple Dot Matrix printer for 65 cycles, (2) recording of data on the diskette with no feedback to VISTA remote printer/plotter but output to Apple printer for the 66th cycle, (3) cessation of recording or printing data for an additional 11 analyses, (4) restart of recording and output of data for a further analysis and (5) recording of data on diskette with feedback to the VISTA remote printer/plotter but no output to the Apple printer for a further four analyses.

Representative outputs for VISTADSKSHORT for analysis No. 34 of the example (CYCLE #s 67 and 68) from the two printers will be described to indicate the format of the presentation. In Figure 4a, the realtime output from the VISTA printer/plotter is given. On the left is the GC trace of the FID detector while the output from the FPD appears on the right. In this impure sample of Malathion, there are two phosphorus-containing components followed by a third component which is not detectable by FPD. Below the gas chromatograms is the VISTA output for the FID, in this case, Channel No. 3. No peak names were assigned in the VISTA methods so that column is blank. Also, no calibration was entered so the RESULT column is 0. The feedback from the Apple is shown in Figure 4b. Minutes are total from 0:00 hrs and the days are counted from 1 January. Peak names would be printed if any had been assigned in the VISTA method. A similar output for Channel No. 4 (the FPD) is then printed as RUN NUMBER:68 followed by the overall summary of both channels by the VISTA. The output on the Apple printer is very similar to the feedback but omits Channel No., Sample ID., Title and Method. It does however, print the "CYCLE # XXX COMPLETED" for ready identification.

Partial printout resulting from VISTASUMMARY is given in Figure 5a for analyses 30-34. The header identifies the output as being for the first cell and gives the date. The header CYCLE NO. identifies the specific analysis being reported and the RETENTION TIME is that determined by the VISTA 401. PEAK AREA (NG/ML) is the concentration of the target material in the gas stream which is based on the calibration factors input at the initiation of the program. In this demonstration, calibration factors of 100,000 and 50,000 digital counts per ng of target material were employed for the FID and FPD detectors respectively. The final column is ELAPSED TIME. This assigns the first recorded analysis as time zero so that the growth or decay of a component relative to that point can be followed.



TITLE: FID 15:37 21 APR 86

CHANNEL NO: 3 SAMPLE: METHOD: 15

PEAK NO	PEAK NAME	RESULT UG/ML	TIME (MIN)	AREA COUNTS	SEP CODE
1		0.00	1.753	114048	VV
2		0.00	1.980	72669	VV
3		0.00	2.125	13548	VV
4		0.00	2.256	364593	VB
TOTALS:		0.00		564858	

Figure 4. PRINTER OUTPUT-VISTADSKSHORT. (a) Output from VISTA 401

CURRENT CYCLE ANALYSIS REPORT

PROGRAM NAME: VISTADISK

RUN NUMBER:67

CHANNEL NO.: 3 SAMPLE ID.:

MINUTES:937 DAYS:111 YEAR: 86

TITLE: FID METHOD: 15

NUMBER OF PEAKS: 4

PEAK NO	PEAK NAME	RETENTION TIME	RESULT
1		1.753	114048
2		1.98	72669
3		2.125	13548
4		2.256	364593

Figure 4. PRINTER OUTPUT-VISTADSKSHORT. (b) Feedback from Apple II+

FOR THE FIRST CELL ON DAY: 111 YEAR: 86

CYCLE NO.	RETENTION TIME IN MINUTES	PEAK AREA(COUNT)	PEAK AREA(NG/ML)	ELAPSED TIME IN MINUTES
30	1.758	52924	.52924	184
30	1.757	19753	.39506	184
31	1.757	61889	.61889	190
31	1.757	24612	.49224	190
32	1.757	69615	.69615	197
32	1.757	28662	.57324	197
33	1.756	75852	.75852	203
33	1.757	32078	.64156	203
34	1.753	114048	1.14048	263
34	1.757	185856	3.71712	263

Figure 5. PRINTER OUTPUT-VISTASUMMARY. (a) First Sample Cell

30	2.275	265441	2.65441	184
30	0	0	0	184
31	2.274	268741	2.68741	190
31	0	0	0	190
32	2.268	275989	2.75989	197
32	0	0	0	197
33	2.266	287427	2.87427	203
33	0	0	0	203
34	2.256	364593	3.64593	263
34	0	0	0	263

Figure 5. PRINTER OUTPUT-VISTASUMMARY. (b) Second Sample Cell

Since this example employed both detectors, there are two rows of response for each analysis; the first for the FID, the second for the FPD detector. For purposes of this demonstration, the retention time ranges for component discrimination were 1.7-1.8 minutes for the first cell and 2.2-2.5 for the second. The result of this discrimation on CYCLE #s 67 and 68 is evident in the printout for No. 34; for the FID, the component at retention time 1.753 is selected while for the FPD, the peak at 1.757 is stored. The corresponding output for the second cell is given in Figure 5b. Here, for the 34th analysis, the component eluting at 2.256 minutes is selected from the four for the FID while the response for the FPD indicates that no detectable phosphorus-containing material eluted in the selected retention time range.

For the purpose of further using the results generated by VISTASUMMARY in the SCIENTIFIC PLOTTER II program, VISTAPLOTFORM is then activated. An example of the output corresponding to the above example, if that option is selected, is shown in Figure 6. The total elapsed time for the test is indicated as well as the maximum concentration reached to aid in responding to specific requests posed in the plotting program. Below the header are two sets of columns consisting of elapsed time of the specific analysis and the concentration of the component of interest in that analysis. Finally, for purposes of concise summary for records, the calibration factor used (100000) and the volume of the sample loop (1) employed is printed. In this example, four such summaries in total would be printed, one for each detector/sample cell combination.

```
TOTAL ELAPSED TIME WAS 263 MINUTES AND MAXIMUM CONCENTRATION WAS 1.14048 NG/ML
0               0               6               0
12              0               18              0
24              0               30              0
36              0               43              0
49              0               55              0
61              0               67              0
74              0               80              0
87              0               93              0
99              0               106             0
112             0               118             0
125             0               131             0
138             0               144             .10476
151             0               157             .10638
164             .13334          171             .24057
177             .41993          184             .52924
190             .61889          197             .69615
203             .75852          263             1.14048
THE DETECTOR FACTOR AND CELL VOLUME ARE 100000                  1
```

Figure 6. PRINTER OUTPUT-VISTAPLOTFORM.

Finally, the graphical output of the behaviour of the selected components recorded by the two detectors for the two sample cells as plotted by SCIENTIFIC PLOTTER II are given in Figure 7. In Figure 7a, the

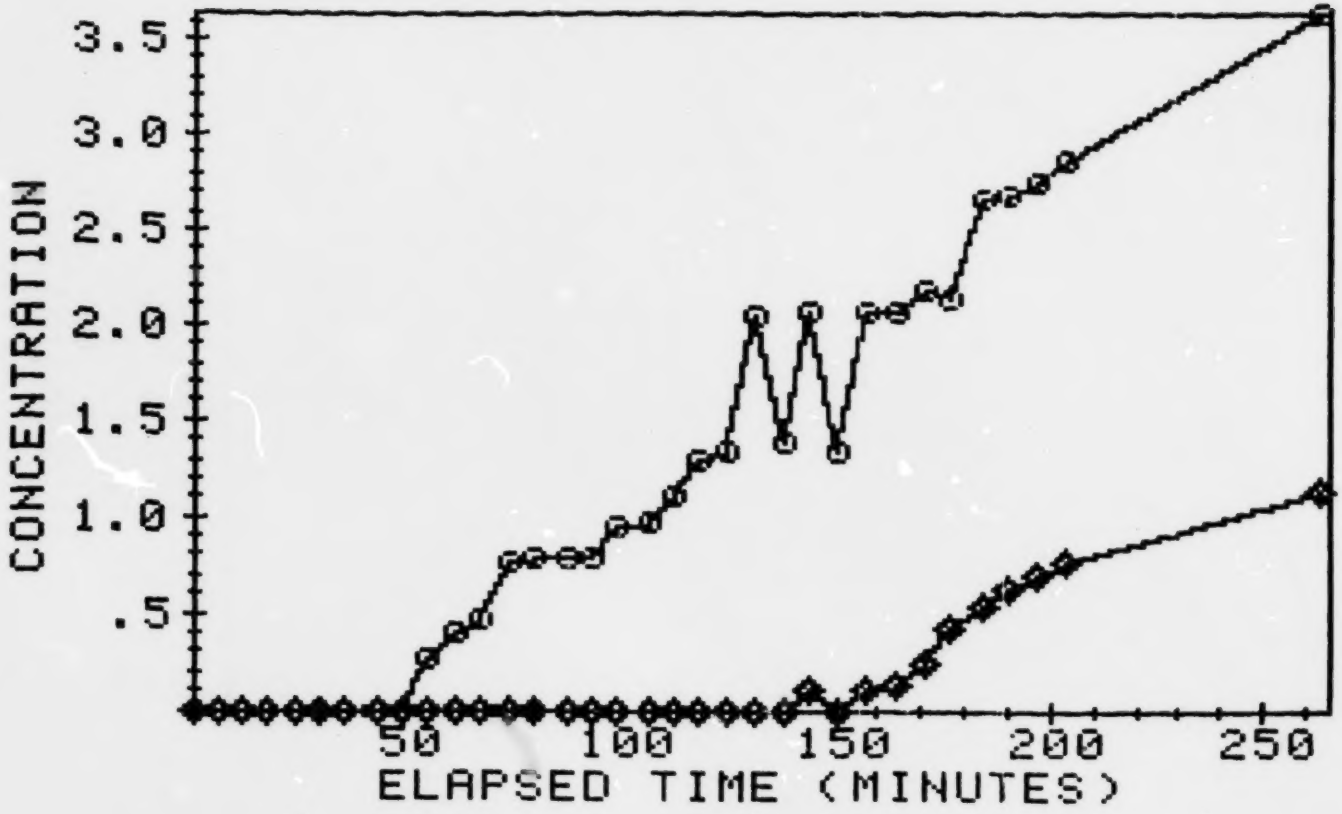


Figure 7. OUTPUT FROM SCIENTIFIC PLOTTER II. (a) FID for both Sample Cells

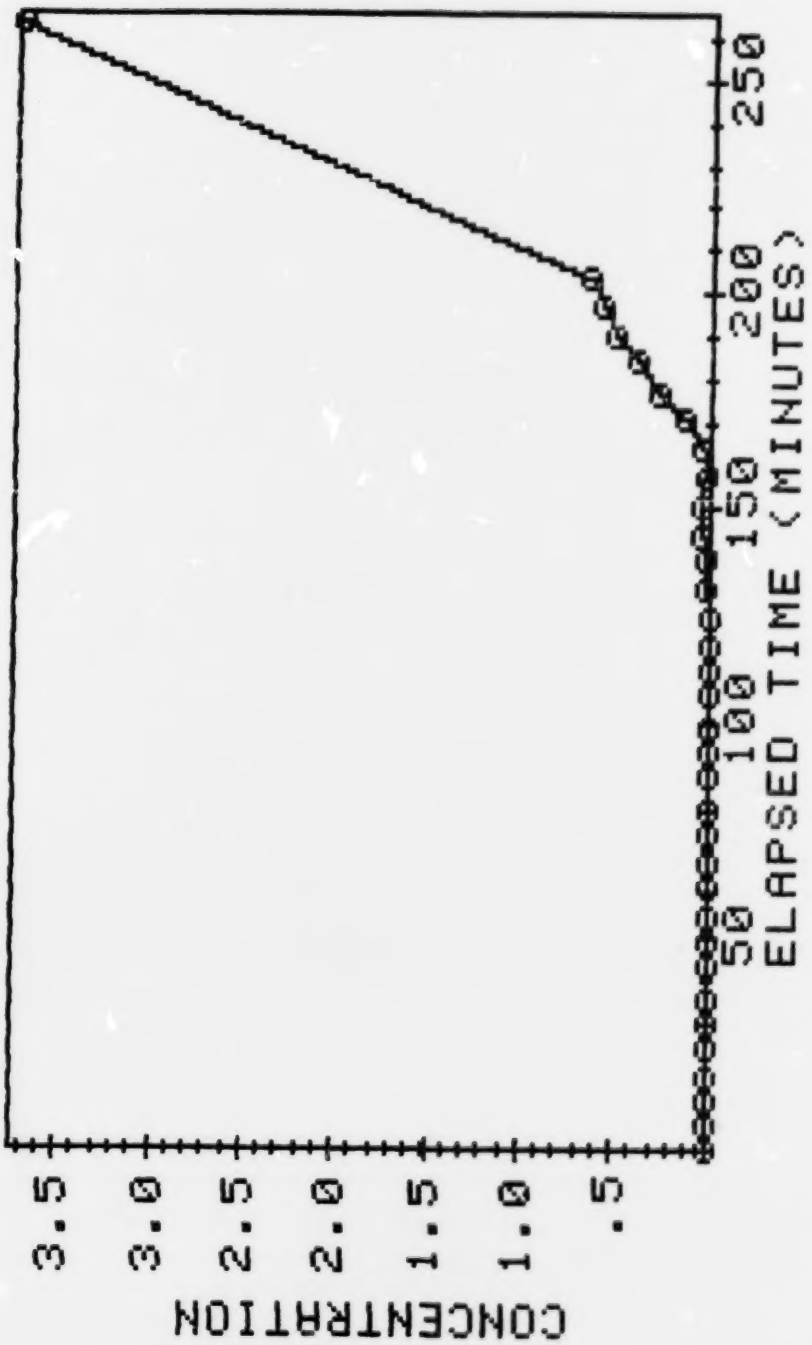


Figure 7. OUTPUT FROM SCIENTIFIC PLOTTER II. (b) FPD for both Sample Cells

lower curve is for the the FID results from the first sample cell, the upper for the second; Figure 7b is the FPD response.

This example has been carried out using two specific retention time windows. If there is a further requirement to examine other components from the analysis, the programs VISTASUMMARY and VISTAPLOTFORM can be rerun with the new selections being entered in response to the appropriate queries. Rerunning the programs will overwrite the files previously created. If this is not desired, the original data discs for each subsequent examination or the Summaries, etc. can be copied to a separate diskette with appropriate identifying file names.

4.0 CONCLUSION

An automated system comprised of two Varian dual-detector gas chromatographs, a Varian Chromatography Data system, an Apple II+ microcomputer with supporting software and gas desorption cells has been developed. This system permits the automatic repetitive analysis of specific vapours desorbing from or penetrating through test materials as well as the analysis of the residual components in the material. As a demonstration of the application of the system, the analysis of Malathion desorbing from a glass slide in the desorption cell as it was heated has been performed and a description of the functions of the specific components and software programs has been given. In addition to providing a listing of the concentration of the desorbing Malathion as a function of elapsed time, graphical representations of the results have been generated using a commercially-available software package. This is only one application of a system which could be used in any examination in which repetitive sampling of a flowing gas stream for analysis of a specific target component or components is required.

5.0 REFERENCES

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2. VISTA 401 Chromatography Data System Operators Manual, Publication Number 03-913859-00, Varian Associates, Inc. 1980.

3. VISTA-PLUS Operators Manual, Publication Number 03-913901-00, Varian Associates, Inc. 1981.

4. THE NAVIGATOR, L. Swoboda, Nibble, 6, 14 (1985)

5. CURVE FITTER for Apple II, Interactive Microware, Inc., State College, PA, USA.

6. SCIENTIFIC PLOTTER VERSION II for Apple II, Interactive Microware, Inc., State College, PA, USA.

```
40    REM
      ************************************************************
50    REM   ******* PROGRAM:VISTADSKSHORT-STORE VISTA DATA ON DISK
      *****
60    REM   ***** WITH OPTION OF DUAL DETECTORS AND INPUTS
      ***********
70    REM
      ************************************************************
71    DATA   "001","002","003","004","005","006","007","008","009",
      "010"
72    DATA   "011","012","013","014","015","016","017","018","019",
      "020"
73    DATA   "021","022","023","024","025","026","027","028","029",
      "030"
74    DATA   "031","032","033","034","035","036","037","039","039",
      "040"
75    DATA   "041","042","043","044","045","046","047","048","049",
      "050"
76    DATA   "051","052","053","054","055","056","057","058","059",
      "060"
77    DATA   "061","062","063","064","065","066","067","068","069",
      "070"
78    DATA   "071","072","073","074","075","076","077","078","079",
      "080"
79    DATA   "081","082","083","084","085","086","087","088","089",
      "090"
80    DATA   "091","092","093","094","095","096","097","098","099",
      "100"
81    DATA   "101","102","103","104","105","106","107","108","109",
      "110"
82    DATA   "111","112","113","114","115","116","117","118","119",
      "120"
83    DATA   "121","122","123","124","125","126","127","128","129",
      "130"
84    DATA   "131","132","133","134","135","136","137","138","139",
      "140"
85    DATA   "141","142","143","144","145","146","147","148","149",
      "150"
86    DATA   "151","152","153","154","155","156","157","158","159",
      "160"
87    DATA   "161","162","163","164","165","166","167","168","169",
      "170"
88    DATA   "171","172","173","174","175","176","177","178","179",
      "180"
89    DATA   "181","182","183","184","185","186","187","188","189",
      "190"
90    DATA   "191","192","193","194","195","196","197","198","199",
      "200"
98    ONERR GOTO 1500
100   DIM A%(50), R(30), T(30), PN$(30)
130   NM$ = "VISTADSKSHORT"
    : D$ = "A"
    : HOME
    : VTAB 4
    : PRINT SPC(9);"APPLE II PLUS STORAGE"
```



```
220   VTAB 6
    : PRINT SPC(10);"FOR VARIAN VISTA 401"
    : VTAB 8
    : PRINT SPC(9);"FILE STORAGE ON DISC"
240   VTAB 10
    : PRINT SPC(10);"PROGRAM :";NM$
    : D$ = CHR$(4)
261   CT = 1
    : E = 1
    : PRINT "IN THE FOLLOWING,"0=NO,1=YES"
271   INPUT "IS THIS A DUAL PROCEDURE?";R1
274   INPUT "IS OUTPUT ON REMOTE PRINTER DESIRED?";R2
276   INPUT "IS OUTPUT ON APPLE PRINTER DESIRED?";R3
280   INPUT "INPUT # OF PREVIOUS RUN(NORMALLY 0)";RN
281   IF RN = 0
        GOTO 298
290   IF R1 = 0
        THEN RN = RN + 1
292       FOR NJ = 1 TO RN
        : READ N$
        : NEXT
298   RN = RN + 1
    : READ N$
    : PRINT ""
    : VTAB 16
    : PRINT SPC(13);"RUN NUMBER:";RN
    : PRINT ""
325   VTAB 17
    : HTAB 11
    : FLASH
    : PRINT CHR$(7);"   WAITING FOR DATA   "
    : NORMAL
330   CALL 852
340       FOR I = 1 TO 4
350       GOSUB 60700
        : GOSUB 61000
        : IF XX < > 0
            GOTO 1500
370       IF I < > 1
            GOTO 400
375       PR# 0
        : IN# 0
        : CALL 1002
        : VTAB 17
        : PRINT SPC(39);
        : HTAB 14
        : FLASH
        : PRINT CHR$(7);"RECEIVING DATA"
        : NORMAL
        : CALL 852
380       IF XX = 1
            GOTO 410
385       I = I + 1
400       IF I < > 2
            GOTO 410
405       IF D$(2) < > "5" AND D$(2) < > "13"
            THEN XX = 5
```

```
410         A$(I) = BX$
          : BX$ = "A"
          : IF I < > 3
              GOTO 450
425         DA = VAL(SX$(1))
          : DD = VAL(SX$(2))
          : DY = VAL(SX$(3))
450         NEXT I
480   NP = VAL(SX$(5))
482         FOR J = 1 TO 30
          : R(J) = 0
          : T(J) = 0
          : NEXT J
500         FOR I = 1 TO NP
          : BX$ = "A"
          : GOSUB 60700
          : GOSUB 61000
          : IF XX < > 0
              GOTO 1500
530         A$(I + 4) = BX$
          : R(I) = VAL(SX$(5))
          : T(I) = VAL(SX$(3))
          : PN$(I) = SX$(1)
560         NEXT I
600   I = NP + 4
610   I = I + 1
    : BX$ = "A"
    : GOSUB 60700
    : IF XX < > 0
        GOTO 1500
620   A$(I) = BX$
650   IF BX$ < > "Q#"
        GOTO 610
660   E = 2
    : IF XX < > 0
        GOTO 1500
959   PR# 0
    : IN# 0
    : CALL 1002
    : E = 1
    : B$ = ",D2"
962   VTAB 17
    : PRINT SPC(10);
    : FLASH
    : PRINT CHR$(7);"SAVING DATA ON DISK"
    : NORMAL
963   O$ = "OPEN CYCLE "
    : W$ = "WRITE CYCLE "
    : C$ = "CLOSE CYCLE "
967   A$ = "APPEND CYCLE "
    : R$ = "READ CYCLE "
    : I$ = "CYCLE "
970   IF RN > 100
        THEN B$ = ",D1"
980   PRINT D$;O$ + N$ + B$
    : PRINT D$;W$ + N$
```



```
985   PRINT RN
    : PRINT NP
    : PRINT DA
    : PRINT DD
    : PRINT DY
1030        FOR J = 1 TO NP
          : PRINT T(J)
          : PRINT R(J)
          : NEXT J
1041  PRINT D$;C$ + N$
1042  IF R2 = 1
        GOTO 1047
1045  IF R3 < > 1
        GOTO 1458
1047  VTAB 17
    : PRINT SPC(37);
    : HTAB 9
    : FLASH
    : PRINT CHR$(7);"READING RESULTS FROM DISK"
    : NORMAL
1050  PRINT D$;O$ + N$
    : PRINT D$;R$ + N$
1057  INPUT RN, NP, DA, DD, DY
1065        FOR L = 1 TO NP
          : INPUT T(L), R(L)
          : NEXT L
1105  PRINT D$;C$ + N$
    : IF R2 < > 1
        GOTO 1200
1120  VTAB 17
    : PRINT SPC(39);
    : HTAB 8
    : FLASH
    : PRINT CHR$(7);"PRINTING RUN IDENTIFICATION"
    : NORMAL
    : CALL 852
1122  PRINT "A"
1125  PRINT SPC(6);"CURRENT CYCLE ANALYSIS REPORT"
    : GOSUB 60500
1130        FOR J = 1 TO 3
          : PRINT ""
          : GOSUB 60500
          : NEXT J
1135  PRINT "PROGRAM NAME: ";NM$
    : GOSUB 60500
    : PRINT ""
    : GOSUB 60500
1136  PRINT "RUN NUMBER: ";RN
    : GOSUB 60500
    : PRINT ""
    : GOSUB 60500
1140  BX$ = A$(2)
    : GOSUB 61000
1145  PRINT "CHANNEL NO.: ";SX$(3), , "SAMPLE ID.: ";SX$(4)
    : GOSUB 60500
```

```
1150  PRINT ""
    : GOSUB 60500
    : BX$ = A$(3)
    : GOSUB 61000
1153  PRINT "MINUTES:";SX$(1), "DAYS:";SX$(2), "YEAR:";SX$(3)
    : GOSUB 60500
1156  PRINT ""
    : GOSUB 60500
    : BX$ = A$(4)
    : GOSUB 61000
1160  PRINT "TITLE:";SX$(1), , "METHOD:";SX$(2)
    : GOSUB 60500
    : PRINT ""
    : GOSUB 60500
1164  PRINT "NUMBER OF PEAKS:";NP
    : GOSUB 60500
1166        FOR J = 1 TO 3
          : PRINT ""
          : GOSUB 60500
          : NEXT J
1168  IF NP = 0
        GOTO 1190
1170  PRINT "-------PEAK";"-------PEAK"; SPC(10);"RETENTION TIME";
      SPC(15);"RESULT"
    : GOSUB 60500
1172  PRINT "--------NO.";"-------NAME"
    : GOSUB 60500
    : PRINT ""
    : GOSUB 60500
1176        FOR J = 1 TO NP
          : M = 8 - LEN(STR$(J))
          : PRINT SPC(M);J;"";
1180        M = 12 - LEN(PN$(J))
          : PRINT SPC(M);PN$(J);
          : M = 20 - LEN(STR$(T(J)))
1183        PRINT SPC(M);T(J);
          : M = 25 - LEN(STR$(R(J)))
          : PRINT SPC(M);R(J)
1186        GOSUB 60500
          : NEXT J
1190  PR# 0
    : IN# 0
    : CALL 1002
1200  IF R3 < > 1
        GOTO 1458
1210  E$ = "PRINTING RESULTS"
1250  VTAB 17
    : PRINT SPC(39);
    : HTAB 14
    : FLASH
    : PRINT CHR$(7);E$
    : NORMAL
    : PR# 1
1252  PRINT CHR$(9);"80N"
    : PRINT SPC(6);"CURRENT CYCLE ANALYSIS REPORT"
1254  PRINT "PROGRAM NAME:";NM$
    : PRINT "RUN NUMBER:";RN
1255  PRINT "MINUTES:";DA, "DAYS:";DD, "YEAR:";DY
```



```
1262  PRINT ""
    : PRINT "NUMBER OF PEAKS:";NP
    :
1264  PRINT "-------PEAK";"-------PEAK"; SPC(13);"RETENTION TIME";
      SPC(15);"RESULT"
1266  PRINT "--------NO.";"-------NAME"
1267        FOR J = 1 TO NP
          : M = 8 - LEN(STR$(J))
          : PRINT SPC(M);J;"";
1270        M = 11 - LEN(PN$(J))
          : PRINT SPC(M);PN$(J);
1272        M = 22 - LEN(STR$(T(J)))
          : PRINT SPC(M);T(J);
1274        M = 27 - LEN(STR$(R(J)))
          : PRINT SPC(M);R(J)
          : NEXT J
1455  E = 1
    : VTAB 14
    : PRINT SPC(39);
    : HTAB 1
    : PRINT SPC(19);I$ + N$;" COMPLETED"
    : PR# 0
1458  IF R1 = 1
        GOTO 1480
1460  RN = RN + 1
    : READ N$
    : GOTO 1482
1480  IF CT = 2
        GOTO 1494
1481  CT = 2
1482  IF R2 = 1
        GOTO 1484
1483  BX$ = "A"
    : GOTO 298
1484  BX$ = "Q"
    : GOTO 298
1494  CT = 1
    : GOTO 1482
1500  IF E = 2 OR BX$ = "Q"
        GOTO 1530
1505  QX = XX
    : CALL 852
1510  IF BX$ ( ) "Q"
        THEN BX$ = "A"
1512  GOSUB 60700
1515  IF XX ( ) 0 AND BX$ = "A"
        GOTO 1530
1520  IF BX$ ( ) "Q"
        GOTO 1510
1525  PRINT "A"
    : XX = QX
1530  POKE 2043, 72
    : PRINT ""
    : GOSUB 60500
    : IF XX ( ) 0
        GOTO 1540
1534  LN = PEEK(218) + PEEK(219) * 256
    : EN = PEEK(222)
```

```
1537  PRINT "~ERROR~CODE:";EN;"~IN~LINE~NUMBER:";LN
    : GOTO 1573
1540  IF XX = 1
        THEN PRINT SPC(8);"*'IMPROPER~ACK'~ERROR*"
1550  IF XX = 2
        THEN PRINT SPC(10);"*BUFFER~OVERFLOW*"
1560  IF XX = 3
        THEN PRINT SPC(7);"*CHARACTER~OUT~OF~RANGE*"
1570  IF XX = 4
        THEN PRINT SPC(9);"*'MUTUAL~ACK'~ERROR*"
1572  IF XX = 5
        THEN PRINT "~*DATA~TYPE~MUST~BE~'CALCULATED~DATA'*"
1573  GOSUB 60500
    : IF E < > 2
        THEN PRINT SPC(11);"*DATA~DISCARDED*"
1575  GOSUB 60500
1577  PRINT SPC(12);"**~NEXT~RUN~**"
    : GOSUB 60500
    : POKE 2043, 200
    : GOTO 298
1600  END
60500 XX = 0
    : CALL 944
60510 IF PEEK(768) < > 65 OR PEEK(769) < > 13
        THEN XX = 1
60520 RETURN
60700 AX = 0
    : XX = 0
    : YX = 0
    : WX = 0
    : IF BX$ = "A"
        THEN AX = 1
60710 PRINT BX$
    : CALL 944
60730 IX = 767
    : BX$ = ""
60750 IX = IX + 1
    : IF IX > 848
        THEN XX = 2
        : GOTO 60840
60760 CX = PEEK(IX)
60780 IF CX < 96 AND CX > 31
        GOTO 60800
60790 IF CX < > 13
        THEN XX = 3
        : YX = CX
        : WX = IX - 767
60800 IF CX = 44
        THEN CX = 64
60810 IF CX < > 13
        THEN BX$ = BX$ + CHR$(CX)
        : GOTO 60750
60830 IF LEFT$(BX$, 2) = "Q*"
        THEN BX$ = "Q*"
60840 IF AX = 0
        THEN ZX = 0
60850 IF AX = 1 AND BX$ = "A"
        THEN ZX = ZX + 1
```



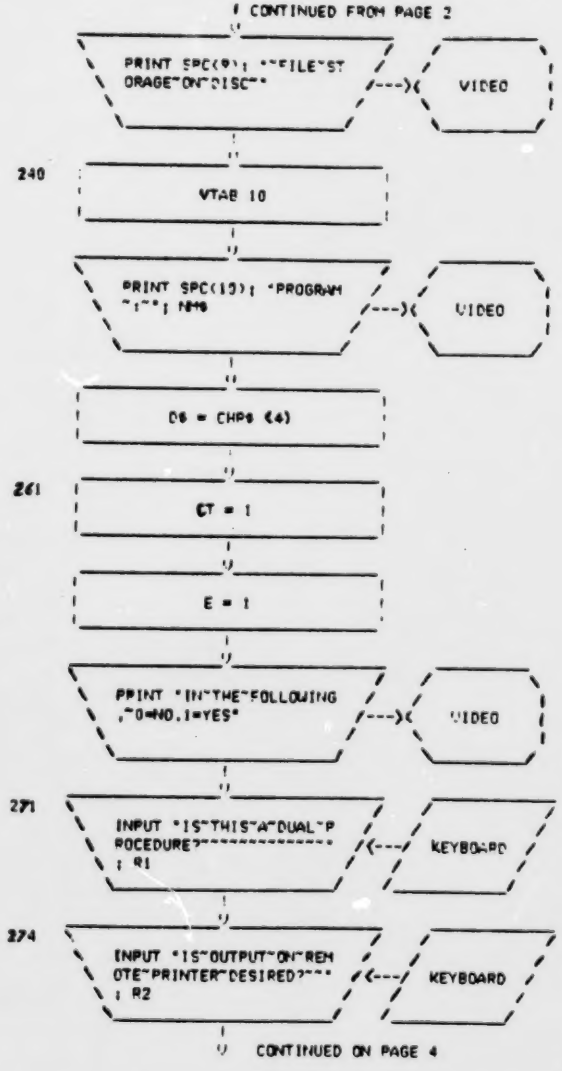
```
60860 IF ZX > = 10
        THEN XX = 5
60870 RETURN
61000 KX = 1
61015 SX$(KX) = ""
        : FOR IX = 1 TO LEN(BX$)
        : CX$ = MID$(BX$, IX, 1)
61040     IF CX$ < > "2"
            GOTO 61070
61050     KX = KX + 1
        : SX$(KX) = ""
        : GOTO 61080
61070     SX$(KX) = SX$(KX) + CX$
61080     NEXT IX
61100 RETURN
61300 BX$ = "X"
61305 DIM LX$(100)
    : XX = 0
    : DX$ = CHR$(4)
    : IX = 0
    : CALL 852
    : PRINT ""
61330 PR# 0
    : IN# 0
    : CALL 1002
    : PRINT DX$;"OPEN~LSTX"
    : PRINT DX$;"WRITE~LSTX"
61360 LIST - 59999
    : PRINT "*#END#*"
    : PRINT DX$;"CLOSE~LSTX"
61380 PRINT DX$;"OPEN~LSTX"
    : PRINT DX$;"READ~LSTX,B";IX
61390     FOR KX = 1 TO 100
61450     CALL 921
        : BX$ = MID$(BX$, 1)
        : IX = IX + LEN(BX$) + 1
61455     IF BX$ = "*#END#*"
            GOTO 61480
61460     LX$(KX) = BX$
        : NEXT KX
61480 PRINT DX$;"CLOSE~LSTX"
    : CALL 852
    : IF KX = 1
      GOTO 61590
61500     FOR JX = 1 TO KX - 1
61502     IF LEN(LX$(JX)) < 81
            GOTO 61510
61503     PRINT LEFT$(LX$(JX), 81)
        : CALL 944
61505     IF PEEK(852) = 32
            GOTO 61508
61506     IF PEEK(768) < > 65 OR PEEK(769) < > 13
            THEN XX = 1
            : GOTO 61590
61508     LX$(JX) = "--------" + RIGHT$(LX$(JX), (LEN(LX$(JX)) - 80))
        : GOTO 61502
```

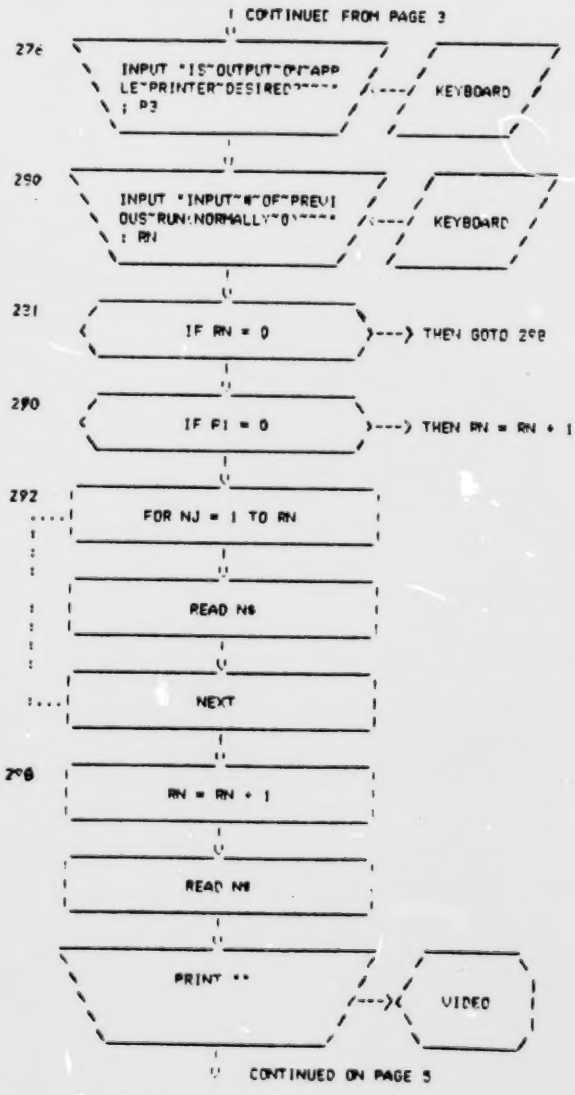
```
61510       PRINT LX$(JX)
          : CALL 944
          : IF PEEK(852) = 32
              GOTO 61540
61530       IF PEEK(768) < > 65 OR PEEK(769) < > 13
              THEN XX = 1
              : GOTO 61590
61540       NEXT JX
61550 IF XX < 101
      GOTO 61590
61560 PR# 0
    : IN# 0
    : CALL 1002
    : GOTO 61380
61590 PRINT "D"
    : PR# 0
    : IN# 0
    : CALL 1002
    : PRINT DX$;"DELETE"LSTX"
61620 END
62000 DX$ = CHR$(4)
    : CALL 852
    : GOSUB 60700
    : PR# 0
    : IN# 0
    : CALL 1002
62060 PRINT DX$;"RUN";BX$;",D1"
62080 END
```

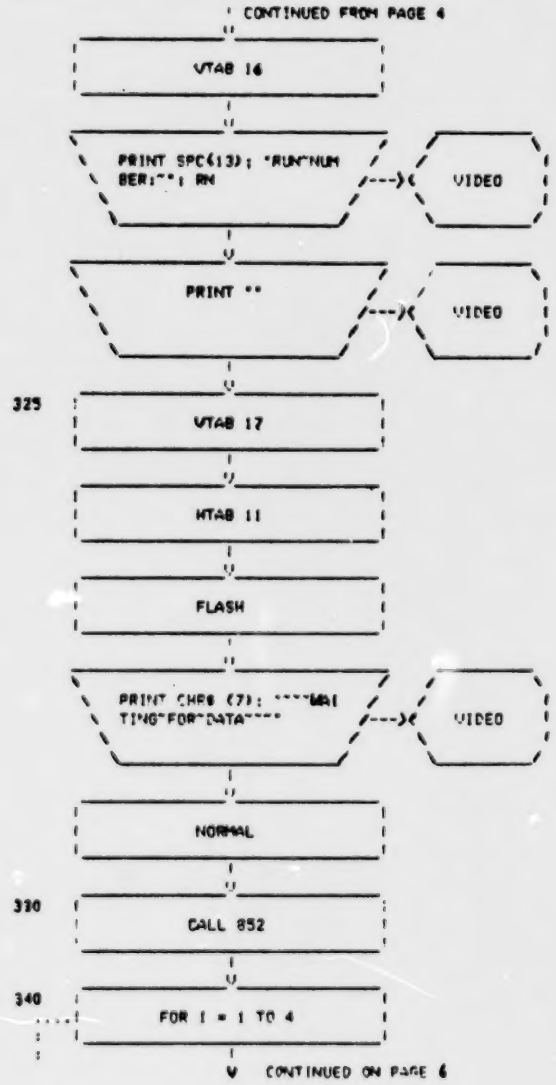
```
                    START
                      |
 40   REM  ***********************************
 50   ***************************
      REM   ******* PROGRAM:VISTADSKSHORT-STORE
      VISTA DATA ON DISK *****
 60   REM   ***** WITH OPTION OF DUAL DETECTORS AND
      INPUTS ***********
 70   REM  ***********************************/***
      ***************************
 71   DATA   "001","002","003","004","005","006",
      "007","008","009","010"
 72   DATA   "011","012","013","014","015","016",
      "017","018","019","020"
 73   DATA   "021","022","023","024","025","026",
      "027","028","029","030"
 74   DATA   "031","032","033","034","035","036",
      "037","038","039","040"
 75   DATA   "041","042","043","044","045","046",
      "047","048","049","050"
 76   DATA   "051","052","053","054","055","056",
      "057","058","059","060"
 77   DATA   "061","062","063","064","065","066",
      "067","068","069","070"
 78   DATA   "071","072","073","074","075","076",
      "077","078","079","080"
 79   DATA   "081","082","083","084","085","086",
      "087","088","089","090"
 80   DATA   "091","092","093","094","095","096",
      "097","098","099","100"
 81   DATA   "101","102","103","104","105","106",
      "107","108","109","110"
 82   DATA   "111","112","113","114","115","116",
      "117","118","119","120"
 83   DATA   "121","122","123","124","125","126",
      "127","128","129","130"
 84   DATA   "131","132","133","134","135","136",
      "137","138","139","140"
 85   DATA   "141","142","143","144","145","146",
      "147","148","149","150"
 86   DATA   "151","152","153","154","155","156",
      "157","158","159","160"
 87   DATA   "161","162","163","164","165","166",
      "167","168","169","170"
 88   DATA   "171","172","173","174","175","176",
      "177","178","179","180"
 89   DATA   "181","182","183","184","185","186",
      "187","188","189","190"
 90   DATA   "191","192","193","194","195","196",
      "197","198","199","200"
        CONTINUED ON PAGE 2
```

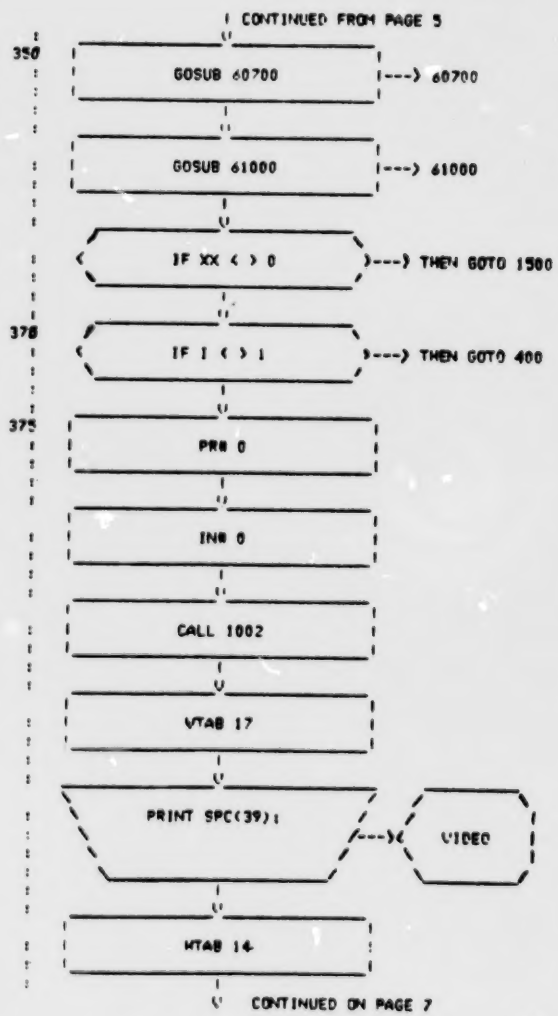


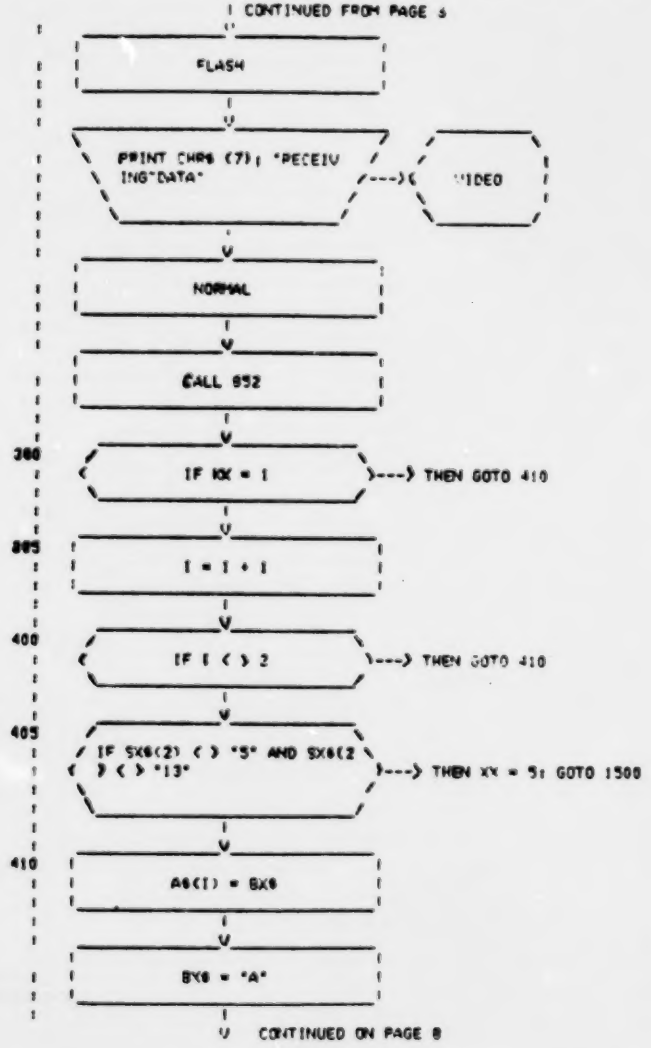
```
                CONTINUED FROM PAGE 1
                      V
 90   ONERR GOTO 1500 ----> 1500
                      |
100   DIM A$(50), R(30), T(30), PN$
      (30)
                      |
                      V
130   NM$ = "VISTADSKSHORT"
                      |
                      V
      BX$ = "A"
                      |
                      V
      HOME
                      |
                      V
      VTAB 4
                      |
                      V
      PRINT SPC(9); "APPLE"II
      "PLUS"STORAGE"  ----> VIDEO
                      |
                      V
220   VTAB 6
                      |
                      V
      PRINT SPC(10); "FOR"VAR
      IAN"VISTA"401"  ----> VIDEO
                      |
                      V
      VTAB 8
                      |
                      V   CONTINUED ON PAGE 3
```

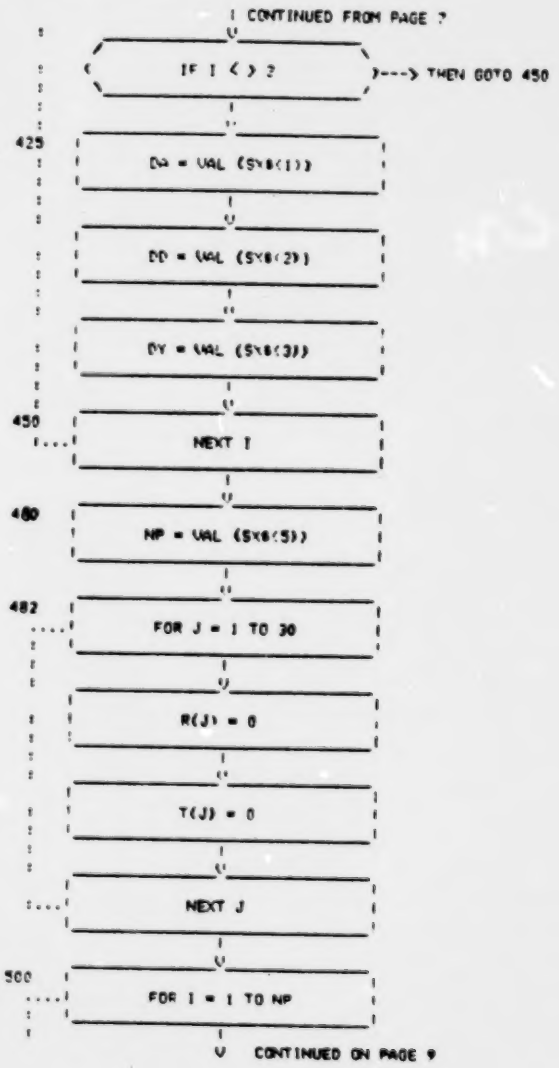

! CONTINUED FROM PAGE 2
PRINT SPC(9);"FILE ST ORAGE ON DISC"
VIDEO
240
VTAB 10
PRINT SPC(13);"PROGRAM ";N$
VIDEO
D$ = CHR$ (4)
261
CT = 1
E = 1
PRINT "IN THE FOLLOWING ,0=NO,1=YES"
VIDEO
271
INPUT "IS THIS A DUAL P ROCEDURE?" ; R1
KEYBOARD
274
INPUT "IS OUTPUT ON REM OTE PRINTER DESIRED?" ; R2
KEYBOARD
CONTINUED ON PAGE 4

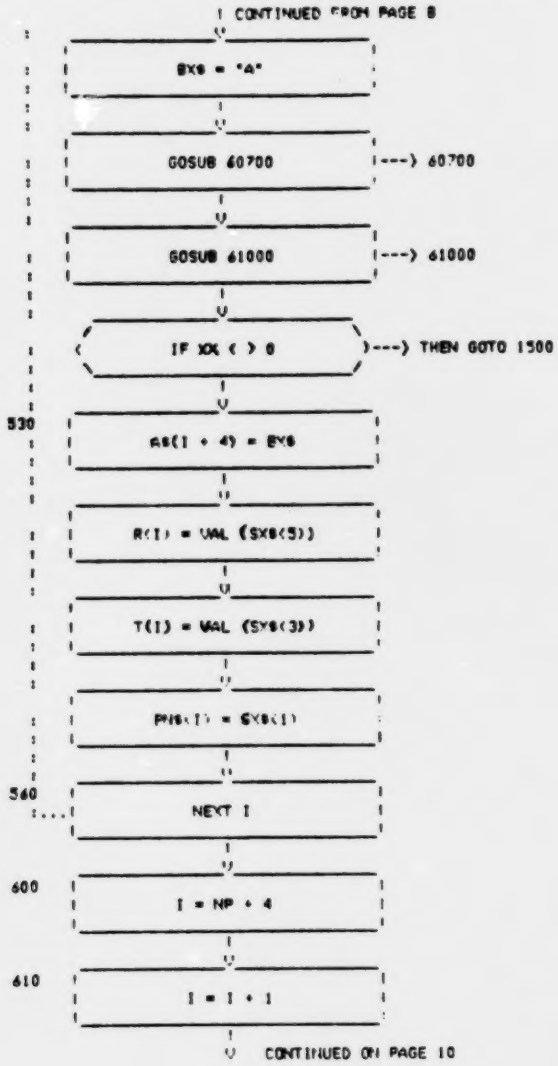

! CONTINUED FROM PAGE 3
276
INPUT "IS OUTPUT ON APP LE PRINTER DESIRED" ; P3
KEYBOARD
290
INPUT "INPUT # OF PREVI OUS RUN: NORMALLY 0" ; RN
KEYBOARD
231
IF RN = 0
THEN GOTO 298
290
IF P1 = 0
THEN RN = RN + 1
292
FOR NJ = 1 TO RN
READ N$
NEXT
298
RN = RN + 1
READ N$
PRINT **
VIDEO
CONTINUED ON PAGE 5

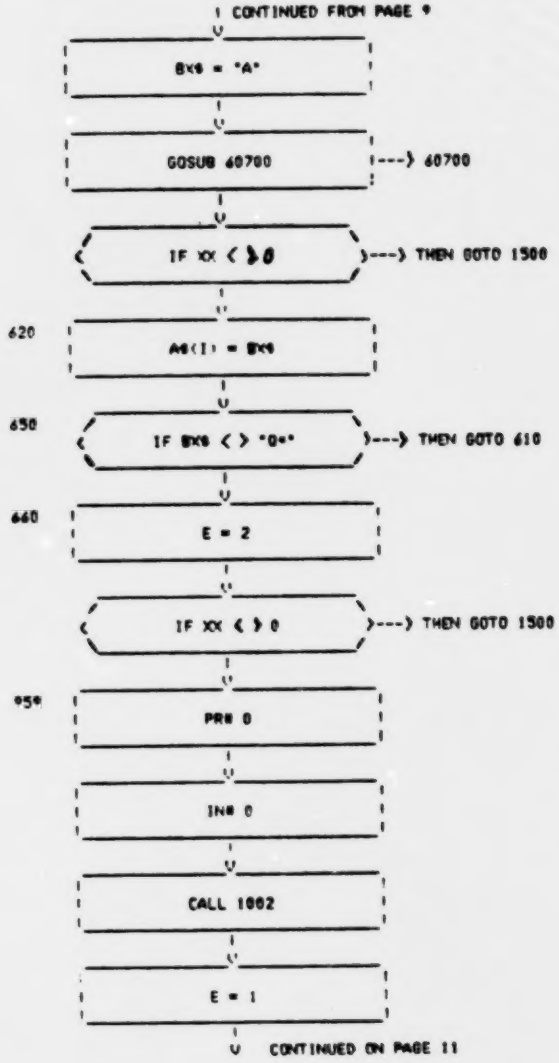

CONTINUED FROM PAGE 4
VTAB 16
PRINT SPC(13); "RUN NUM BER:"; RN
VIDEO
PRINT ""
VIDEO
325
VTAB 17
HTAB 11
FLASH
PRINT CHR$ (7); "WAI TING FOR DATA"
VIDEO
NORMAL
330
CALL 852
340
FOR I = 1 TO 4
CONTINUED ON PAGE 6

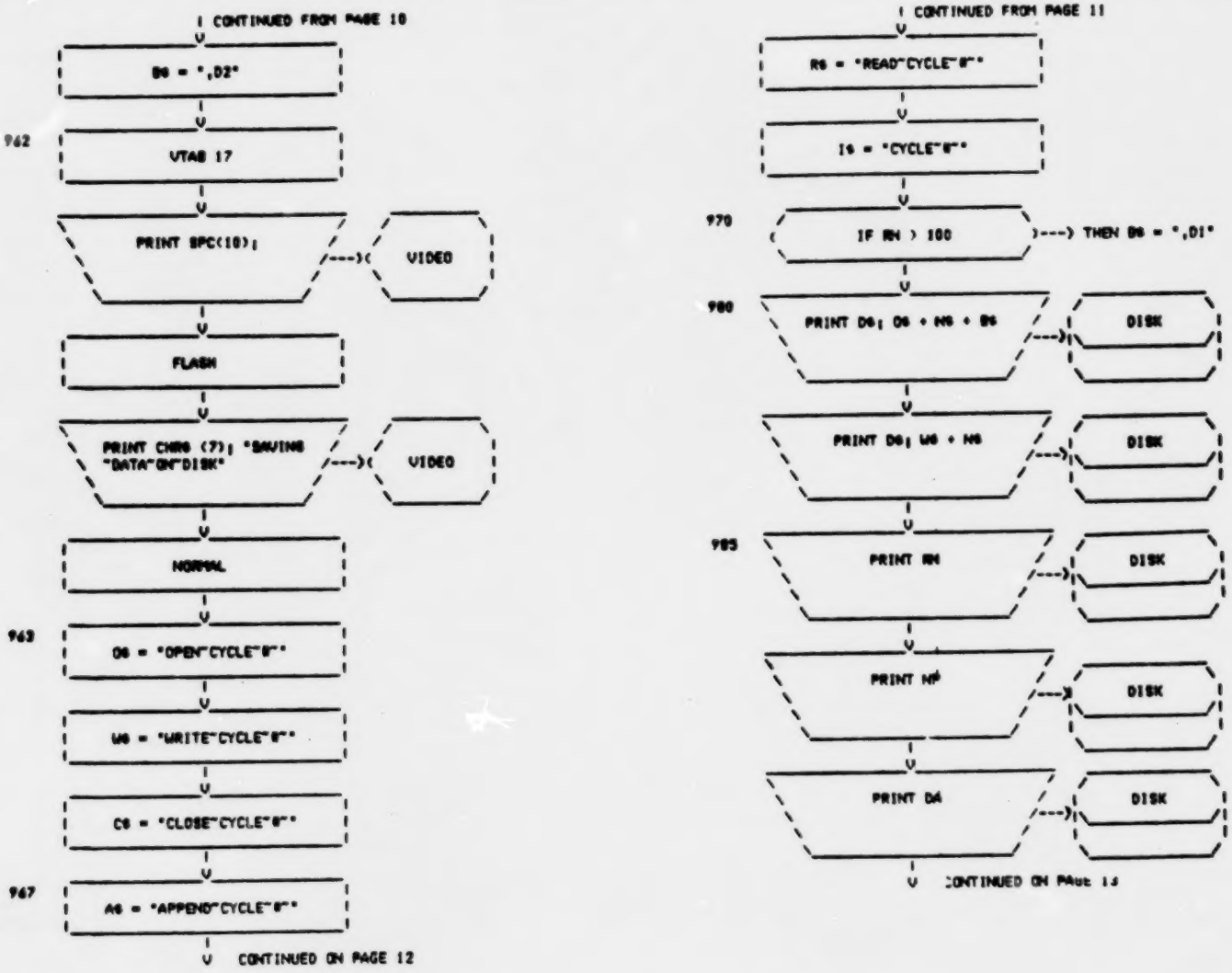

CONTINUED FROM PAGE 5
350
GOSUB 60700
---> 60700
GOSUB 61000
---> 61000
IF XX < > 0
---> THEN GOTO 1500
370
IF I < > 1
---> THEN GOTO 400
375
PR# 0
IN# 0
CALL 1002
VTAB 17
PRINT SPC(39);
VIDEO
HTAB 14
CONTINUED ON PAGE 7


! CONTINUED FROM PAGE 6
FLASH
PRINT CHR$ (7);"RECEIV ING"DATA"
VIDEO
NORMAL
CALL 852
380
IF KX = 1
---> THEN GOTO 410
385
I = I + 1
400
IF I < > 2
---> THEN GOTO 410
405
IF SX$(2) < > "5" AND SX$(2) < > "13"
---> THEN XX = 5: GOTO 1500
410
A$(I) = BX$
BX$ = "A"
V CONTINUED ON PAGE 8

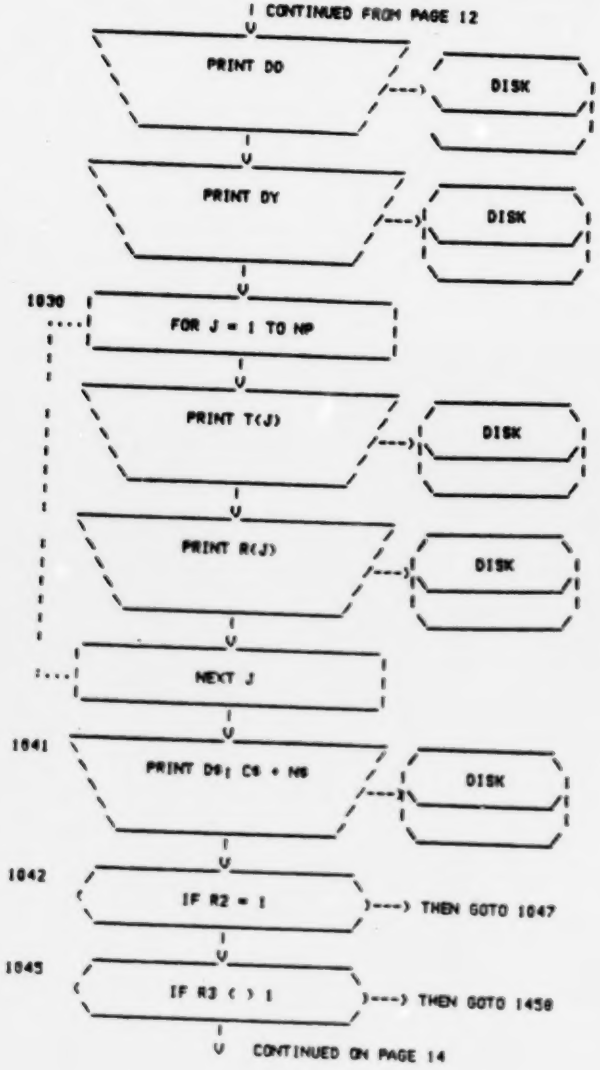

! CONTINUED FROM PAGE 7
IF I < > 2
---> THEN GOTO 450
425
DX = VAL (SX$(1))
DY = VAL (SX$(2))
DY = VAL (SX$(3))
450
NEXT I
480
NP = VAL (SX$(5))
482
FOR J = 1 TO 30
R(J) = 0
T(J) = 0
NEXT J
500
FOR I = 1 TO NP
V CONTINUED ON PAGE 9

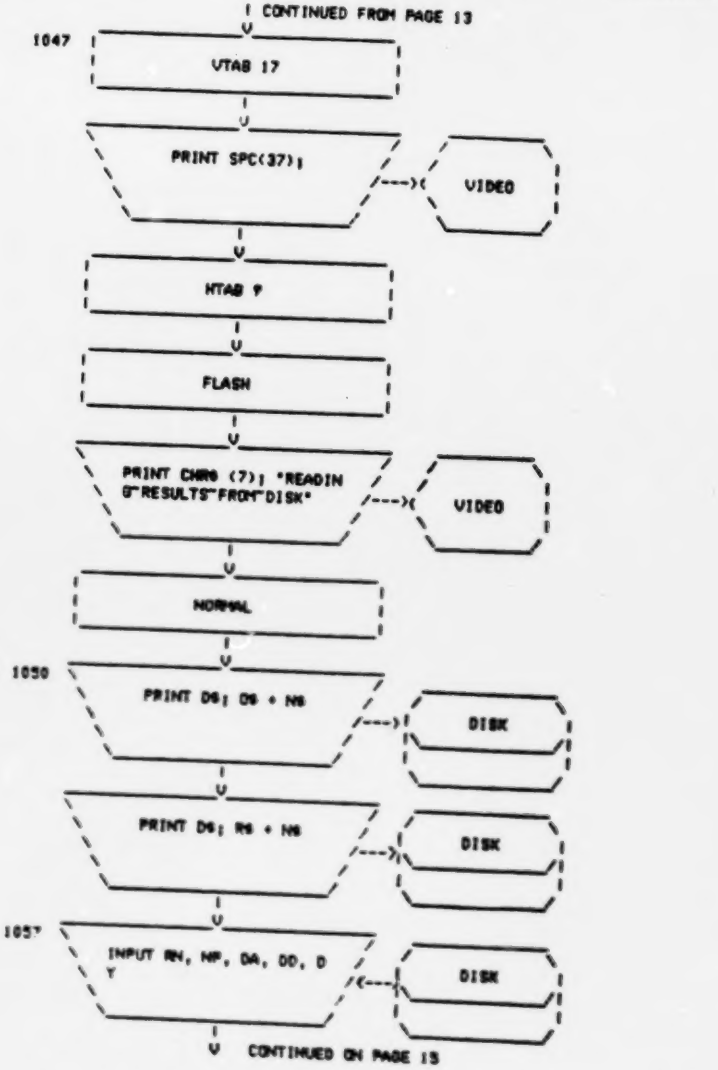

! CONTINUED FROM PAGE 8
BX$ = "A"
GOSUB 60700
---> 60700
GOSUB 61000
---> 61000
IF XX < > 0
---> THEN GOTO 1500
530
A%(I + 4) = BX$
R(I) = VAL (SX$(5))
T(I) = VAL (SY$(3))
PN%(I) = SX%(1)
540
NEXT I
600
I = NP + 4
610
I = I + 1
CONTINUED ON PAGE 10

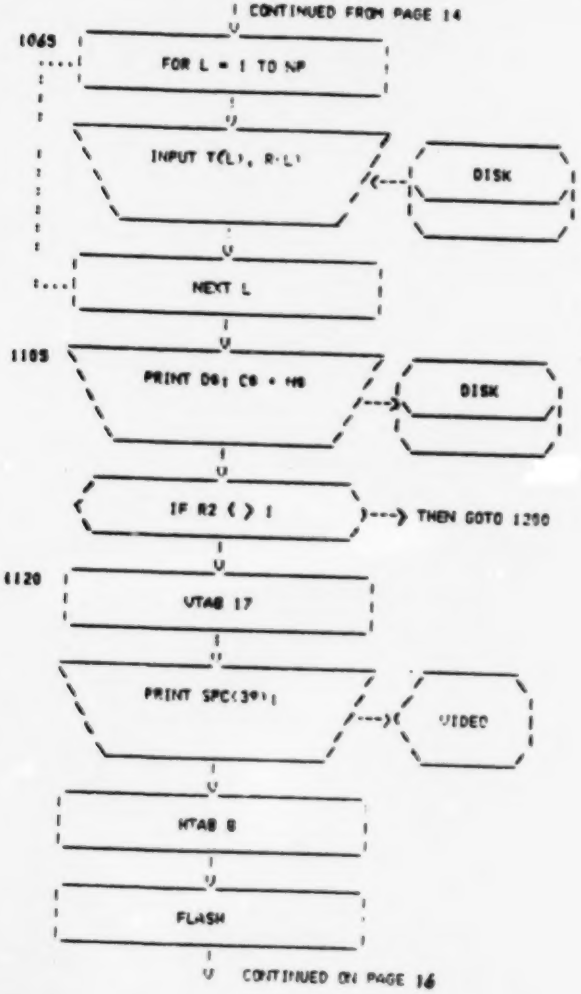

! CONTINUED FROM PAGE 9
BX$ = "A"
GOSUB 60700
---> 60700
IF XX < > 0
---> THEN GOTO 1500
620
A%(I) = BX%
650
IF BX$ < > "0"
---> THEN GOTO 610
660
E = 2
IF XX < > 0
---> THEN GOTO 1500
950
PR# 0
IN# 0
CALL 1002
E = 1
CONTINUED ON PAGE 11

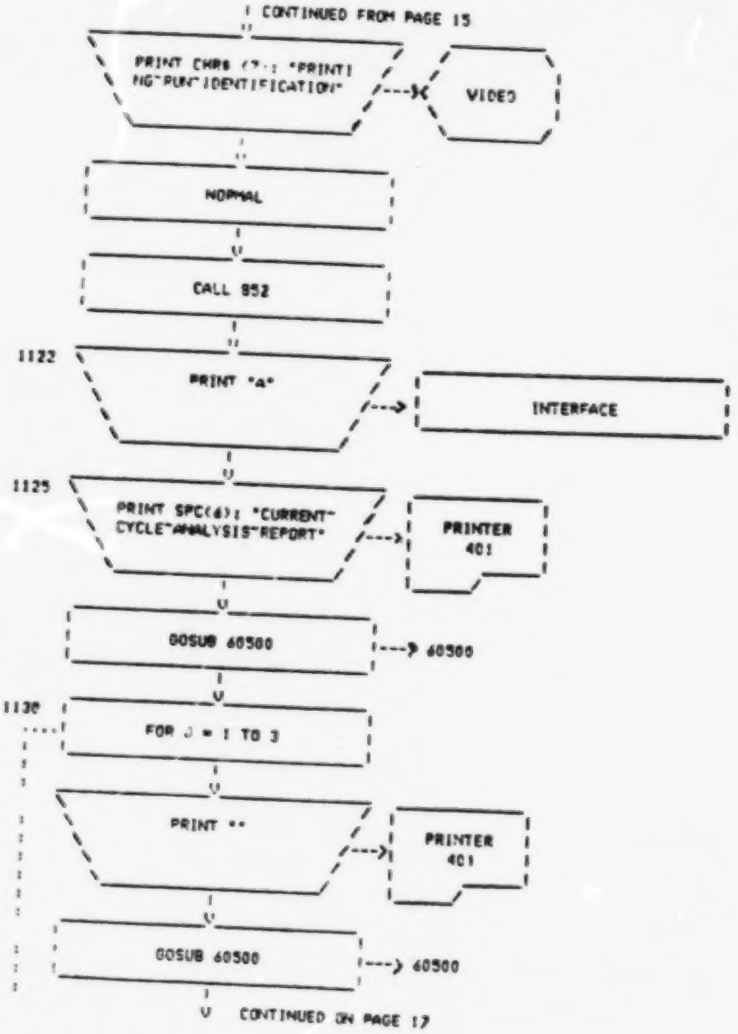


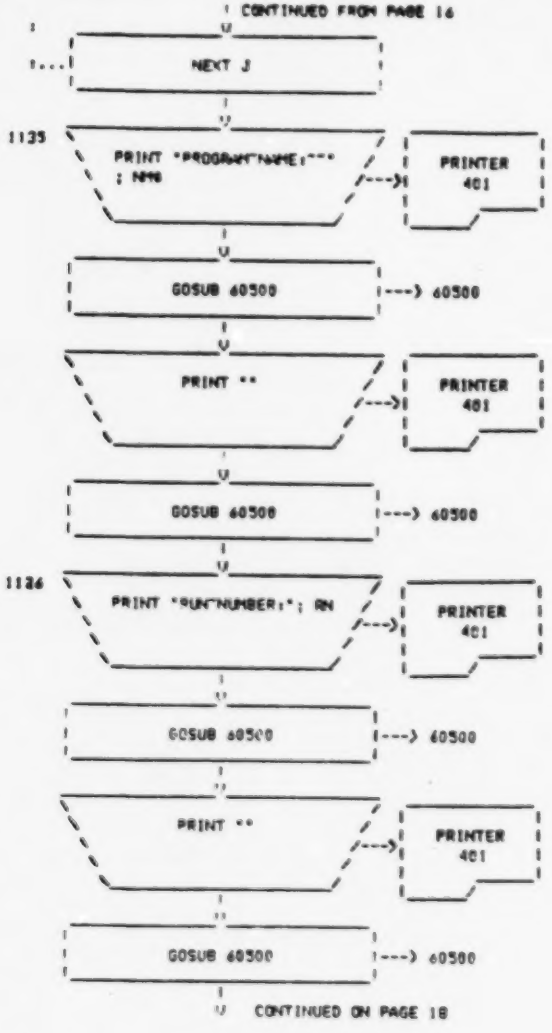
APPENDIX 1. (Cont'd)

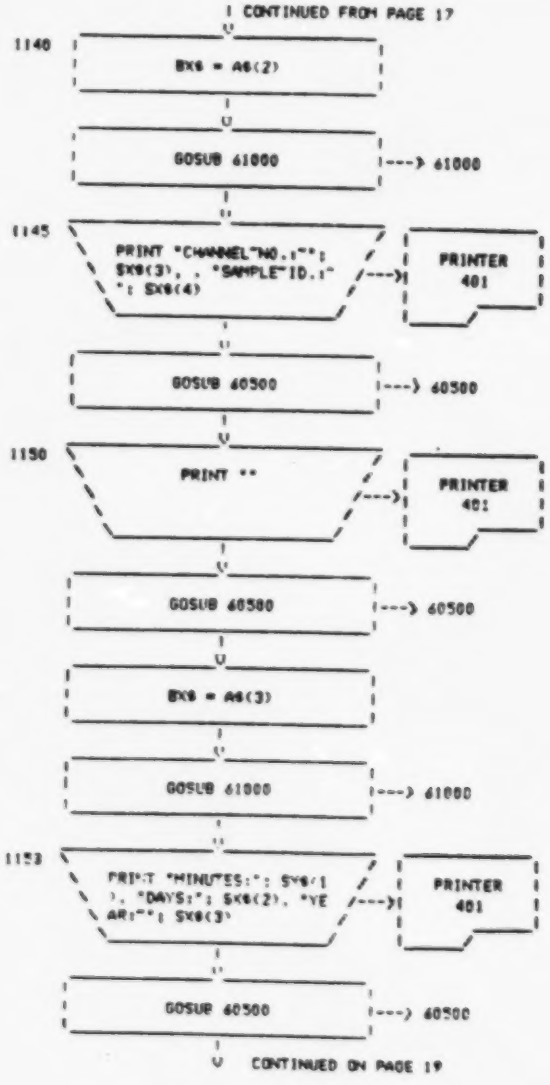

! CONTINUED FROM PAGE 12
PRINT DD
DISK
PRINT DY
DISK
1030
FOR J = 1 TO NP
PRINT T(J)
DISK
PRINT R(J)
DISK
NEXT J
1041
PRINT D$; C$ + N$
DISK
1042
IF R2 = 1
THEN GOTO 1047
1045
IF R3 < > 1
THEN GOTO 1450
CONTINUED ON PAGE 14

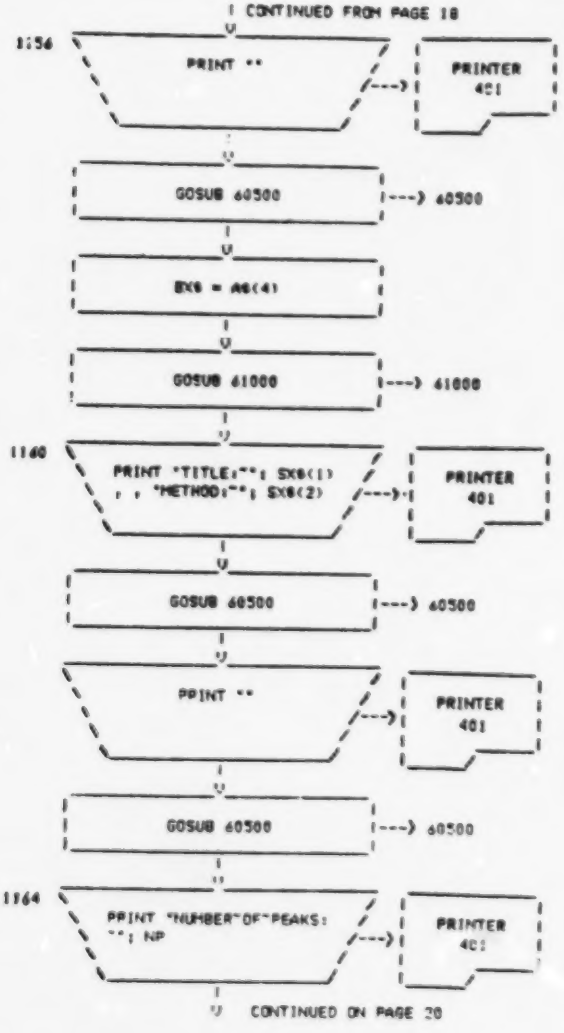

! CONTINUED FROM PAGE 13
1047
VTAB 17
PRINT SPC(37);
VIDEO
HTAB 9
FLASH
PRINT CHR$ (7); "READIN
G"RESULTS"FROM"DISK"
VIDEO
NORMAL
1050
PRINT D$; D$ + N$
DISK
PRINT D$; R$ + N$
DISK
1057
INPUT RN, NP, DA, DD, D
Y
DISK
CONTINUED ON PAGE 15

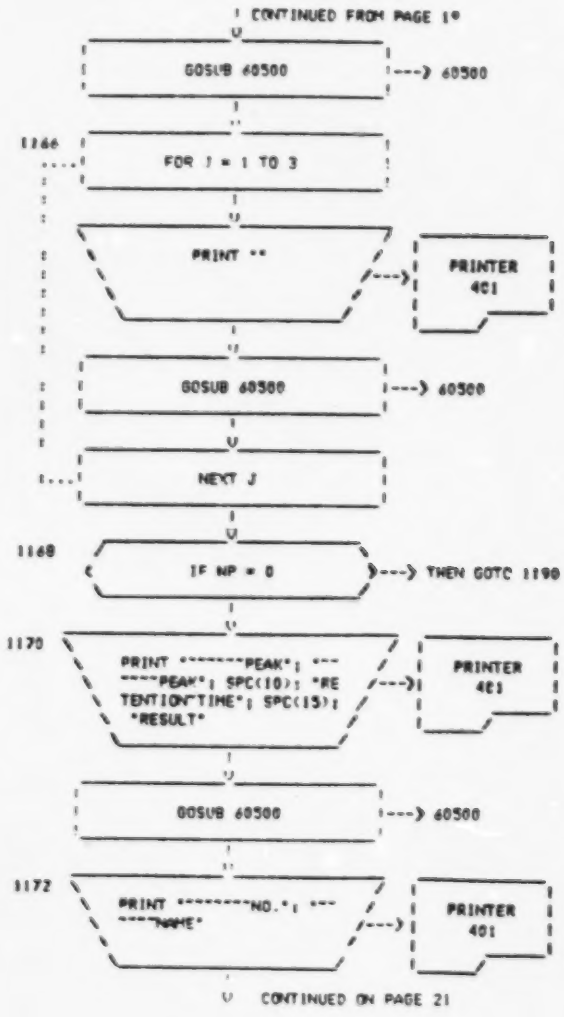

! CONTINUED FROM PAGE 14
1065
FOR L = 1 TO NP
INPUT T(L), R(L)
DISK
NEXT L
1105
PRINT D$; C$ + M$
DISK
IF R2 ( ) 1
THEN GOTO 1250
1120
VTAB 17
PRINT SPC(39);
VIDEO
HTAB 8
FLASH
CONTINUED ON PAGE 16

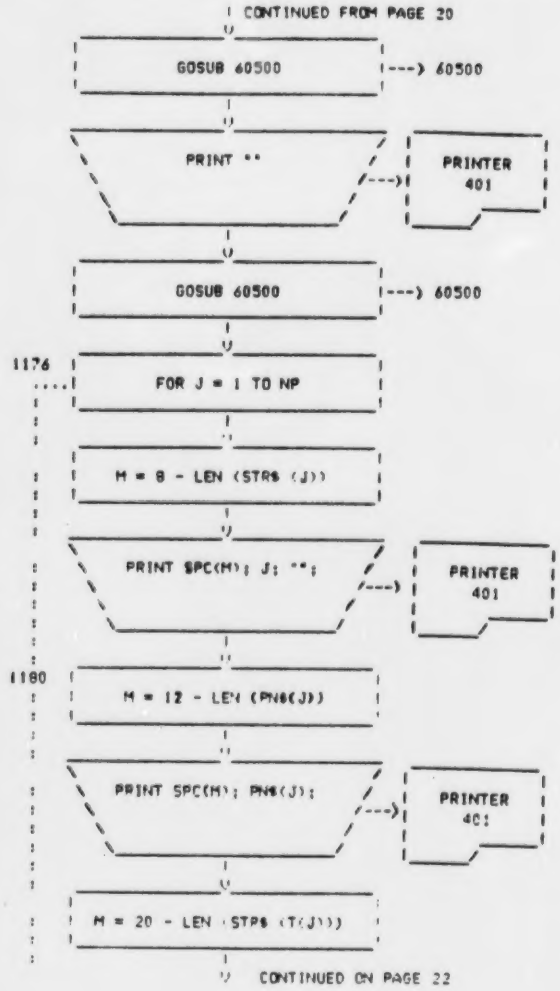

! CONTINUED FROM PAGE 15
PRINT CHR$ (7); "PRINTING" "RUN" IDENTIFICATION"
VIDEO
NORMAL
CALL 852
1122
PRINT "4"
INTERFACE
1125
PRINT SPC(6); "CURRENT" CYCLE" ANALYSIS" REPORT"
PRINTER 401
GOSUB 60500
60500
1130
FOR J = 1 TO 3
PRINT **
PRINTER 401
GOSUB 60500
60500
CONTINUED ON PAGE 17

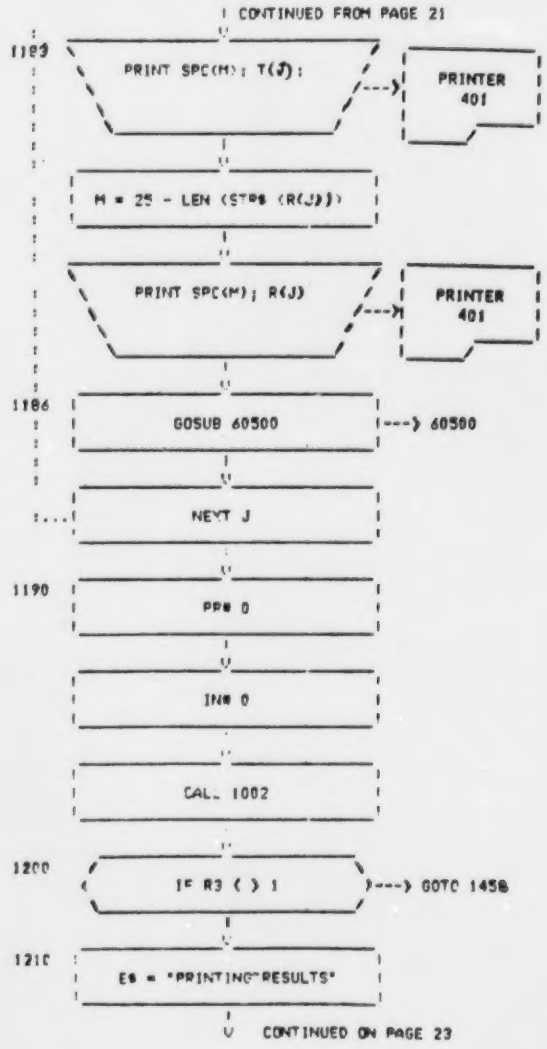

! CONTINUED FROM PAGE 16
NEXT J
1135
PRINT "PROGRAM NAME:"; NM$
PRINTER 401
GOSUB 60500
---> 60500
PRINT ""
PRINTER 401
GOSUB 60500
---> 60500
1136
PRINT "RUN NUMBER:"; RN
PRINTER 401
GOSUB 60500
---> 60500
PRINT ""
PRINTER 401
GOSUB 60500
---> 60500
CONTINUED ON PAGE 18

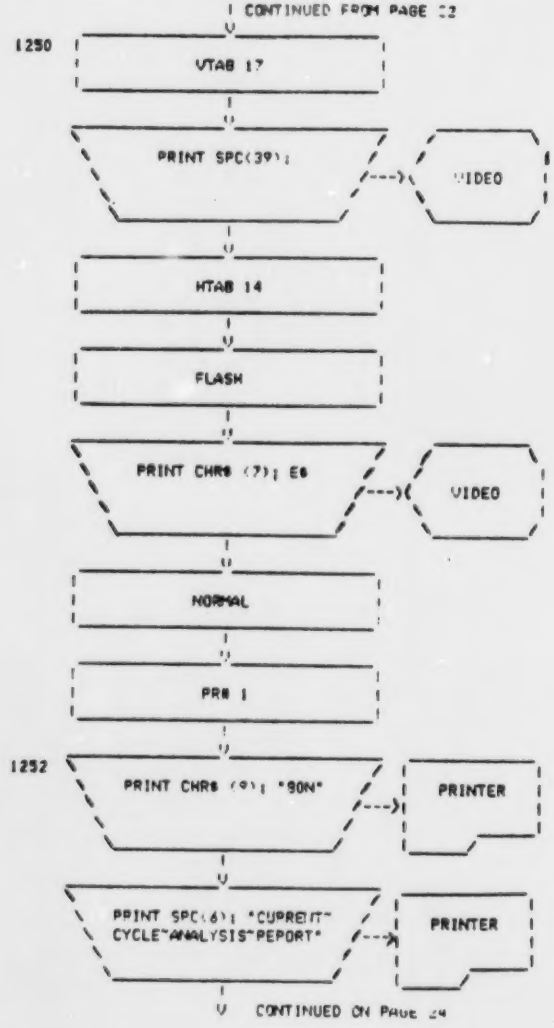

! CONTINUED FROM PAGE 17
1140
BX$ = A$(2)
GOSUB 61000
---> 61000
1145
PRINT "CHANNEL NO.:"; SX$(3), , "SAMPLE ID.:"; SX$(4)
PRINTER 401
GOSUB 60500
---> 60500
1150
PRINT ""
PRINTER 401
GOSUB 60500
---> 60500
BX$ = A$(3)
GOSUB 61000
---> 61000
1153
PRINT "MINUTES:"; SX$(1), "DAYS:"; SX$(2), "YEAR:"; SX$(3)
PRINTER 401
GOSUB 60500
---> 60500
CONTINUED ON PAGE 19

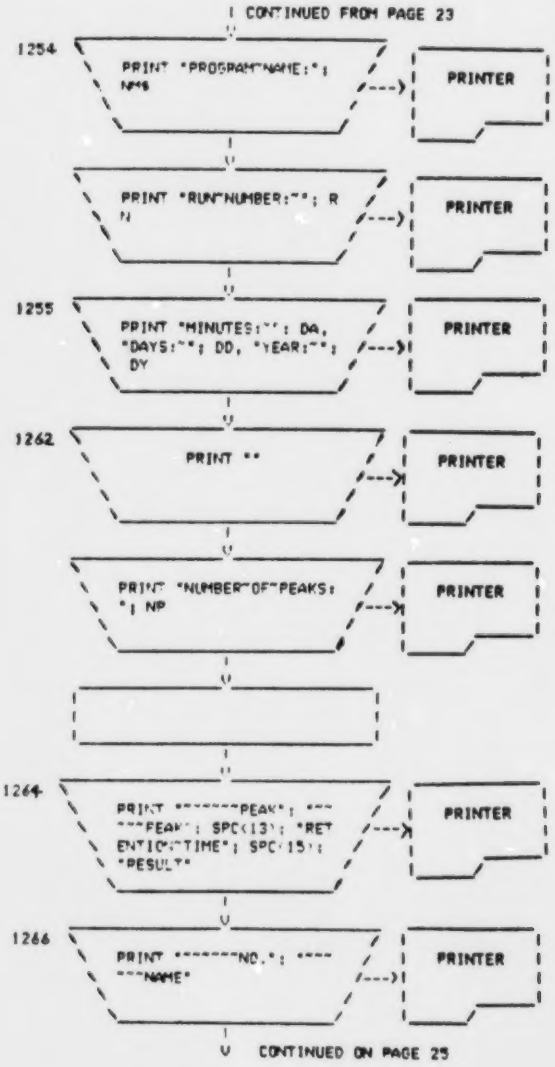

! CONTINUED FROM PAGE 18
1156
PRINT **
PRINTER 401
GOSUB 60500
---> 60500
SX$ = A$(4)
GOSUB 61000
---> 61000
1160
PRINT "TITLE:"; SX$(1) ; ; "METHOD:"; SX$(2)
PRINTER 401
GOSUB 60500
---> 60500
PRINT **
PRINTER 401
GOSUB 60500
---> 60500
1164
PRINT "NUMBER OF PEAKS: "; NP
PRINTER 401
CONTINUED ON PAGE 20

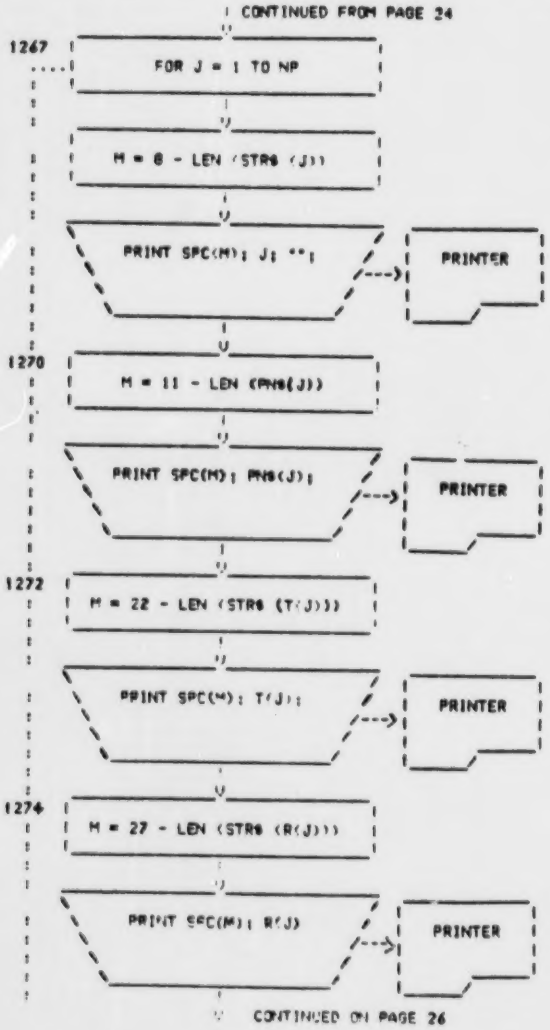

! CONTINUED FROM PAGE 19
GOSUB 60500
---> 60500
1166
FOR J = 1 TO 3
PRINT **
PRINTER 401
GOSUB 60500
---> 60500
NEXT J
1168
IF NP = 0
---> THEN GOTO 1190
1170
PRINT "-------PEAK"; "---------PEAK"; SPC(10); "RETENTION TIME"; SPC(15); "RESULT"
PRINTER 401
GOSUB 60500
---> 60500
1172
PRINT "--------NO."; "---------NAME"
PRINTER 401
CONTINUED ON PAGE 21

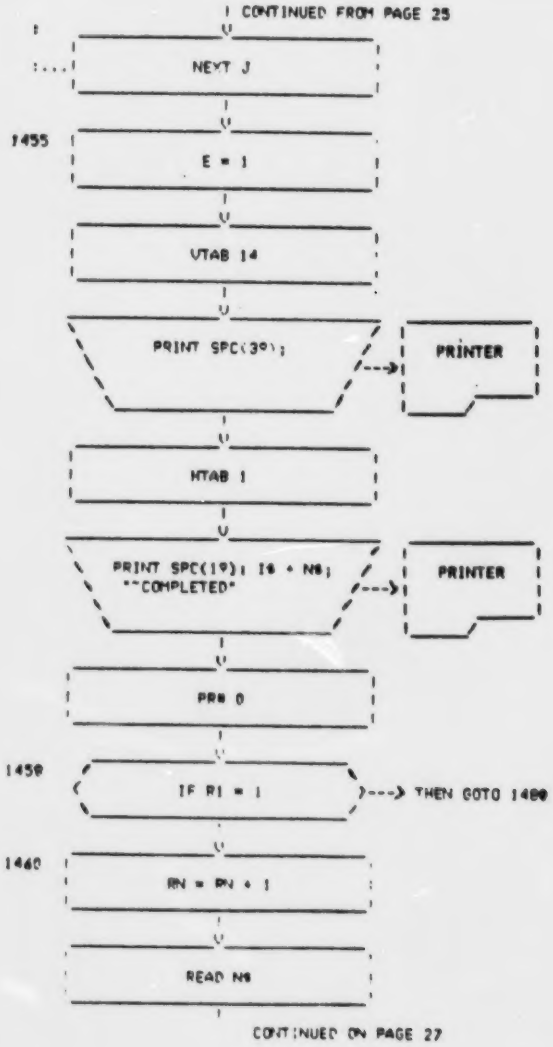

CONTINUED FROM PAGE 20
GOSUB 60500
---> 60500
PRINT **
PRINTER 401
GOSUB 60500
---> 60500
1170
FOR J = 1 TO NP
M = 8 - LEN (STR$ (J))
PRINT SPC(M); J; **;
PRINTER 401
1180
M = 12 - LEN (PN$(J))
PRINT SPC(M); PN$(J);
PRINTER 401
M = 20 - LEN (STR$ (T(J)))
CONTINUED ON PAGE 22

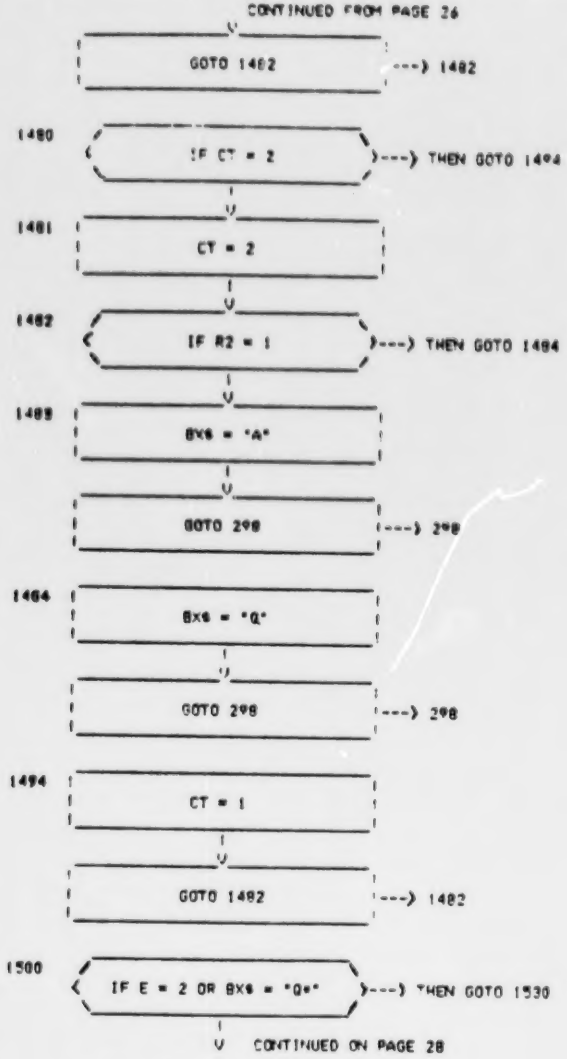

CONTINUED FROM PAGE 21
1183
PRINT SPC(M); T(J);
PRINTER 401
M = 25 - LEN (STR$ (R(J)))
PRINT SPC(M); R(J)
PRINTER 401
1186
GOSUB 60500
---> 60500
NEXT J
1190
PP# 0
IN# 0
CAL 1002
1200
IF R3 ( ) 1
---> GOTO 1458
1210
E$ = "PRINTING RESULTS"
CONTINUED ON PAGE 23

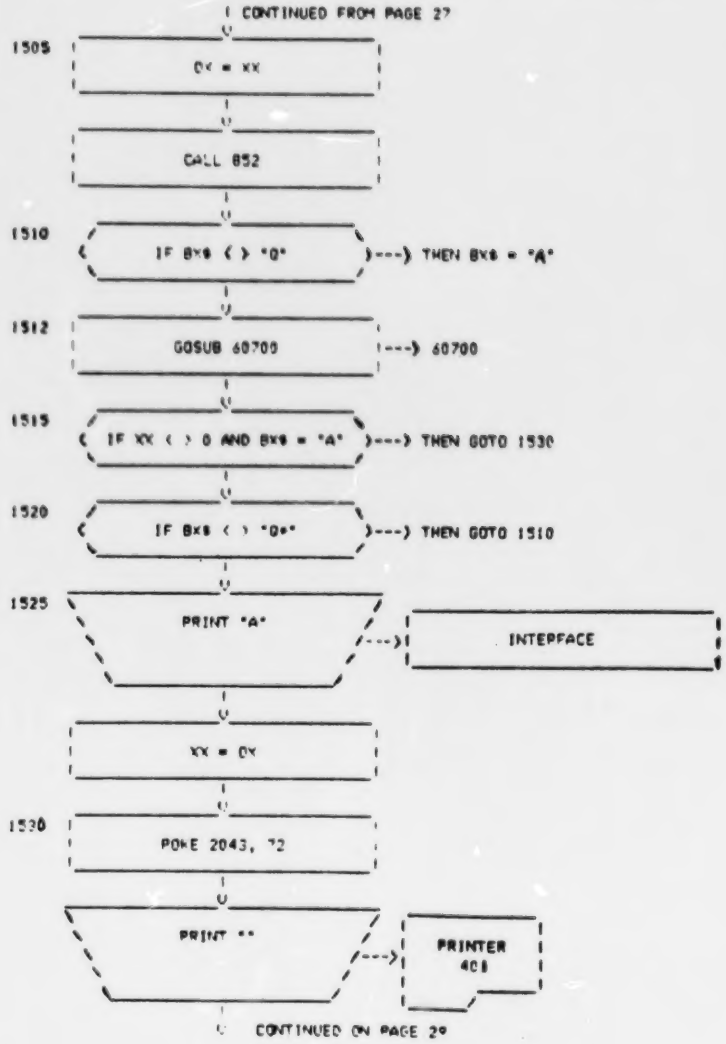

CONTINUED FROM PAGE 22
1250
VTAB 17
PRINT SPC(39);
VIDEO
HTAB 14
FLASH
PRINT CHR$ (7); E$
VIDEO
NORMAL
PR# 1
1252
PRINT CHR$ (9); "90N"
PRINTER
PRINT SPC(6); "CURRENT"
CYCLE"ANALYSIS"REPORT"
PRINTER
CONTINUED ON PAGE 24

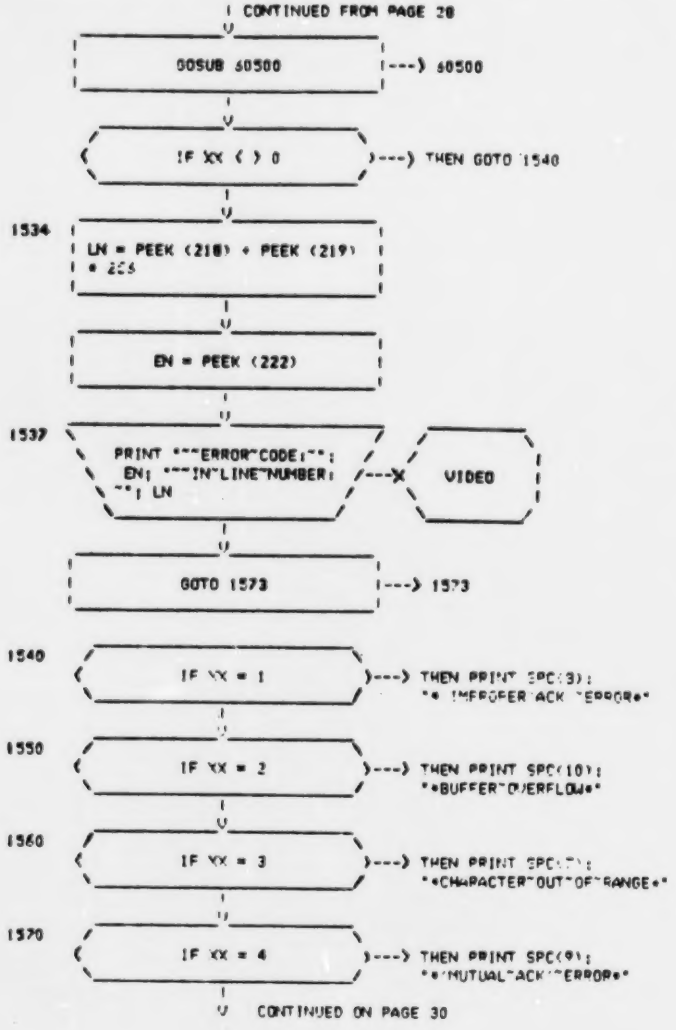

CONTINUED FROM PAGE 23
1254
PRINT "PROGRAM"NAME:";
N$
PRINTER
PRINT "RUN"NUMBER:"; R
N
PRINTER
1255
PRINT "MINUTES:"; DA,
"DAYS:"; DD, "YEAR:";
DY
PRINTER
1262
PRINT ""
PRINTER
PRINT "NUMBER"OF"PEAKS:
"; NP
PRINTER
1264
PRINT "------PEAK"; "---
---PEAK"; SPC(13); "RET
ENTION"TIME"; SPC(15);
"RESULT"
PRINTER
1266
PRINT "------NO."; "----
---NAME"
PRINTER
CONTINUED ON PAGE 25

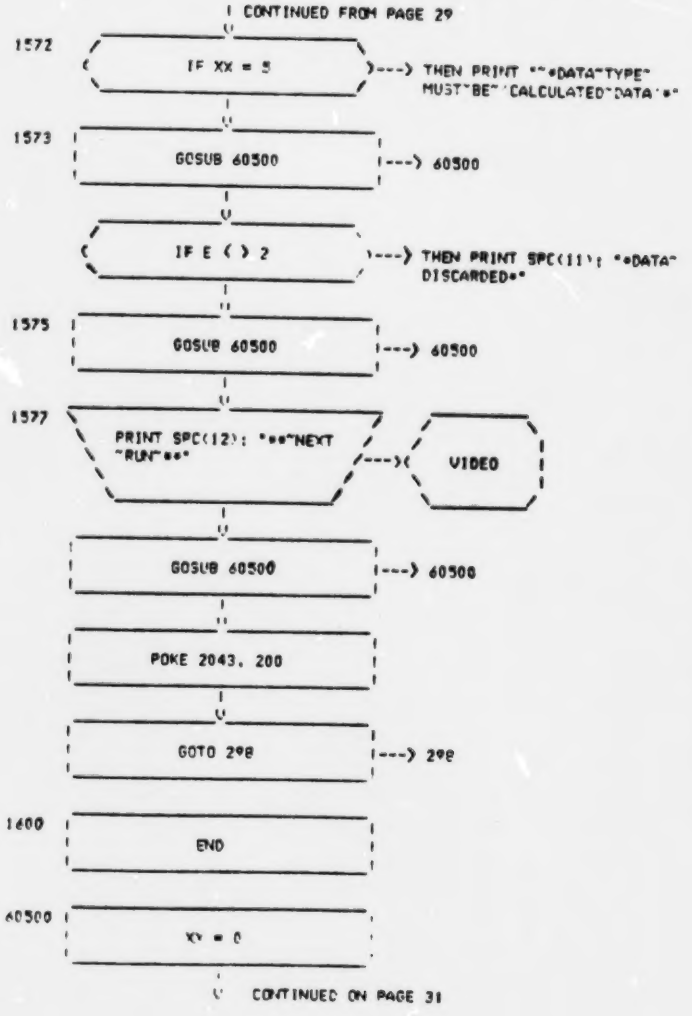

CONTINUED FROM PAGE 24
1267
FOR J = 1 TO NP
M = 8 - LEN (STR$ (J))
PRINT SPC(M); J; "";
PRINTER
1270
M = 11 - LEN (PN$(J))
PRINT SPC(M); PN$(J);
PRINTER
1272
M = 22 - LEN (STR$ (T(J)))
PRINT SPC(M); T(J);
PRINTER
1274
M = 27 - LEN (STR$ (R(J)))
PRINT SPC(M); R(J)
PRINTER
CONTINUED ON PAGE 26

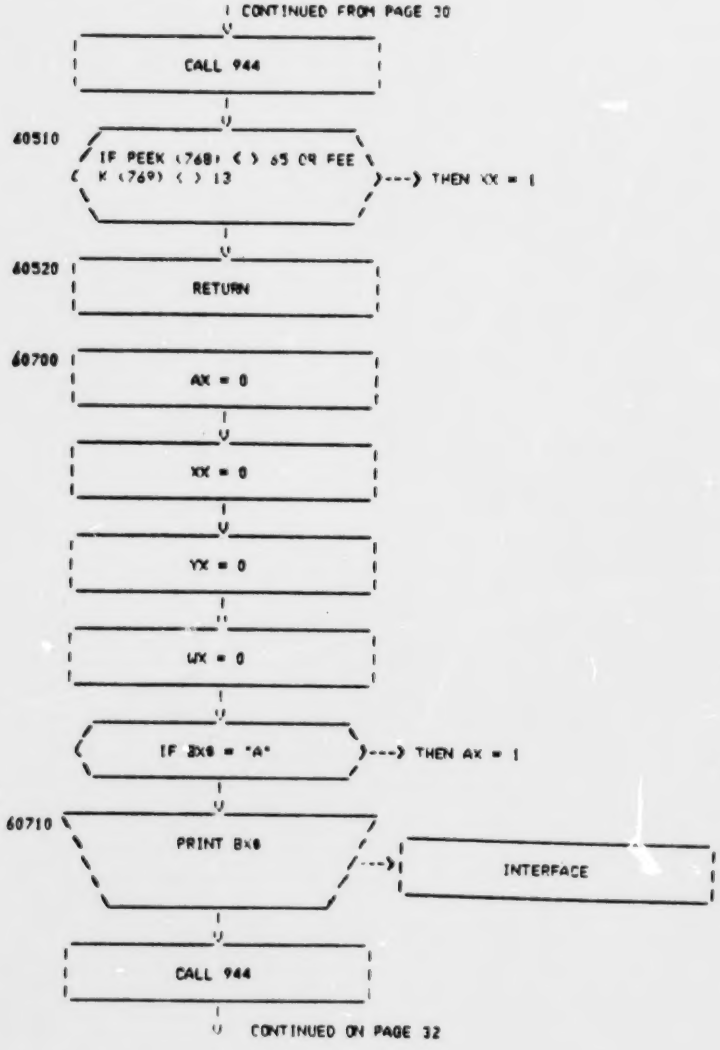

CONTINUED FROM PAGE 25
NEXT J
1455
E = 1
VTAB 14
PRINT SPC(39);
PRINTER
HTAB 1
PRINT SPC(19); I$ + N$; "COMPLETED"
PRINTER
PR# 0
1459
IF R1 = 1
THEN GOTO 1480
1460
RN = RN + 1
READ N$
CONTINUED ON PAGE 27

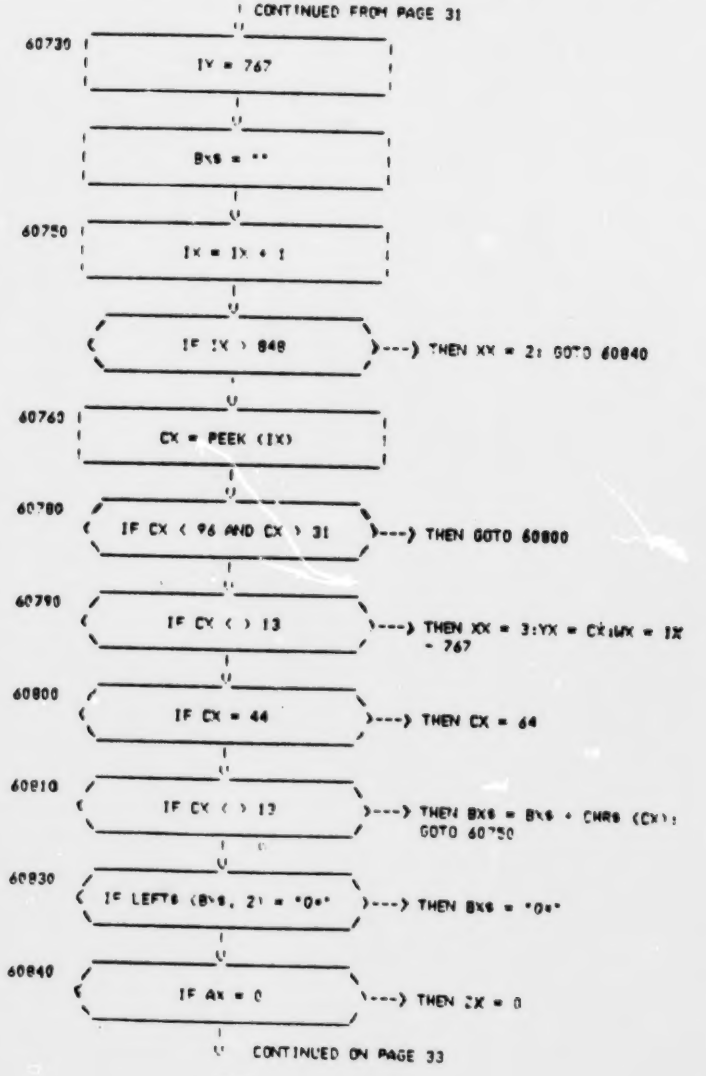

CONTINUED FROM PAGE 26
GOTO 1482
---> 1482
1480
IF CT = 2
---> THEN GOTO 1494
1481
CT = 2
1482
IF R2 = 1
---> THEN GOTO 1484
1483
BX$ = "A"
GOTO 298
---> 298
1484
BX$ = "Q"
GOTO 298
---> 298
1494
CT = 1
GOTO 1482
---> 1482
1500
IF E = 2 OR BX$ = "Q"
---> THEN GOTO 1530
CONTINUED ON PAGE 28

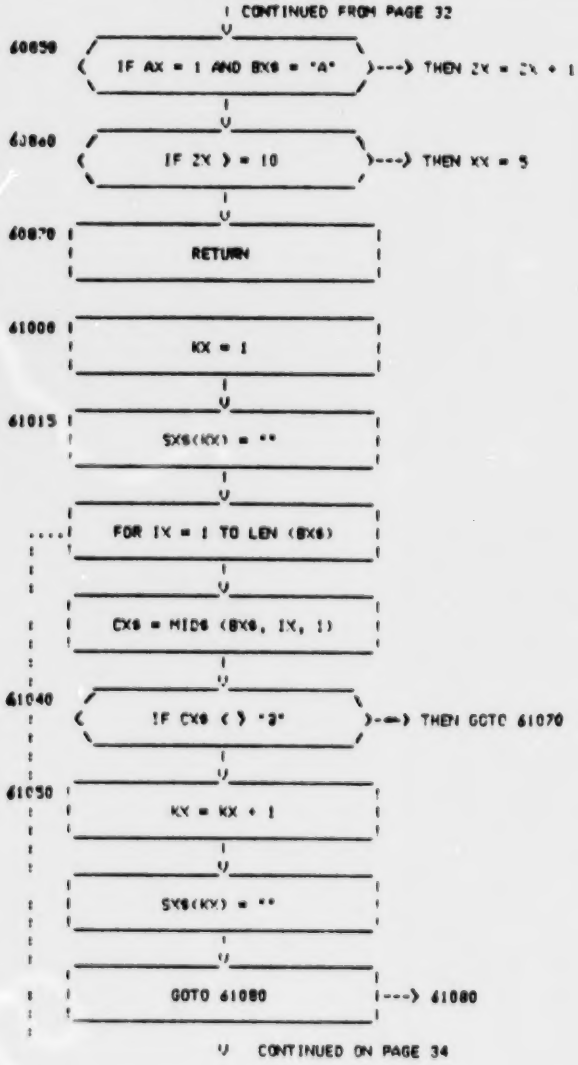

CONTINUED FROM PAGE 27
1505
DX = XX
CALL 852
1510
IF BX$ < > "Q"
---> THEN BX$ = "A"
1512
GOSUB 60700
---> 60700
1515
IF XX < > 0 AND BX$ = "A"
---> THEN GOTO 1530
1520
IF BX$ < > "Q"
---> THEN GOTO 1510
1525
PRINT "A"
---> INTERFACE
XX = DX
1530
POKE 2043, 72
PRINT **
---> PRINTER 408
CONTINUED ON PAGE 29

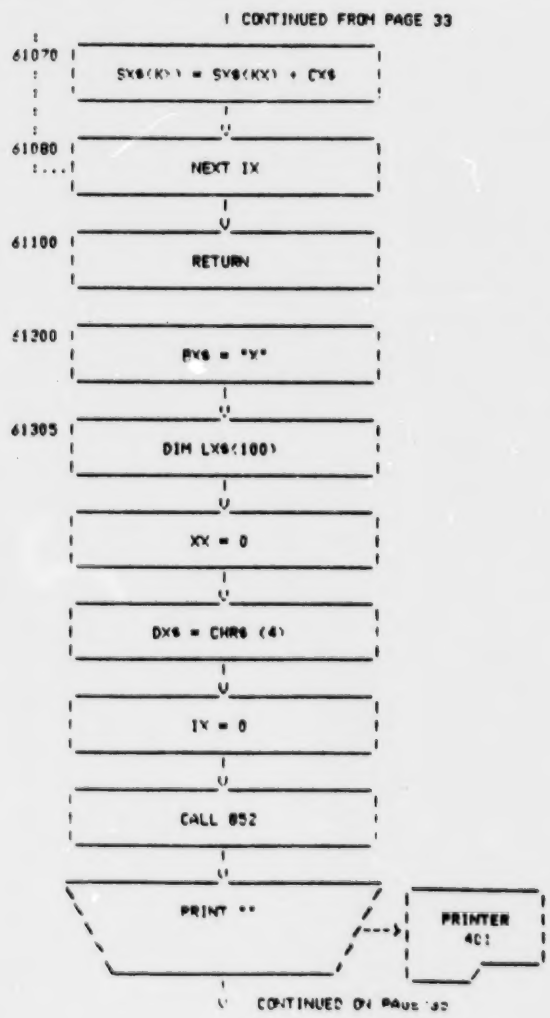

CONTINUED FROM PAGE 28
GOSUB 60500
---> 60500
IF XX ( ) 0
---> THEN GOTO 1540
1534
LN = PEEK (218) + PEEK (219) * 256
EN = PEEK (222)
1537
PRINT ""ERROR"CODE:"";EN;""IN"LINE"NUMBER:""";LN
VIDEO
GOTO 1573
---> 1573
1540
IF XX = 1
---> THEN PRINT SPC(3);"* IMPROPER ACK "ERROR*"
1550
IF XX = 2
---> THEN PRINT SPC(10);"*BUFFER"OVERFLOW*"
1560
IF XX = 3
---> THEN PRINT SPC(
"*CHARACTER"OUT"OF"RANGE*"
1570
IF XX = 4
---> THEN PRINT SPC(9);"*"MUTUAL"ACK""ERROR*"
CONTINUED ON PAGE 30


CONTINUED FROM PAGE 29
1572
IF XX = 5
---> THEN PRINT ""*DATA"TYPE" MUST"BE" 'CALCULATED"DATA'*"
1573
GOSUB 60500
---> 60500
IF E ( ) 2
---> THEN PRINT SPC(11); "*DATA" DISCARDED*"
1575
GOSUB 60500
---> 60500
1577
PRINT SPC(12); "**"NEXT "RUN"**"
VIDEO
GOSUB 60500
---> 60500
POKE 2043, 200
GOTO 298
---> 298
1600
END
60500
XX = 0
CONTINUED ON PAGE 31

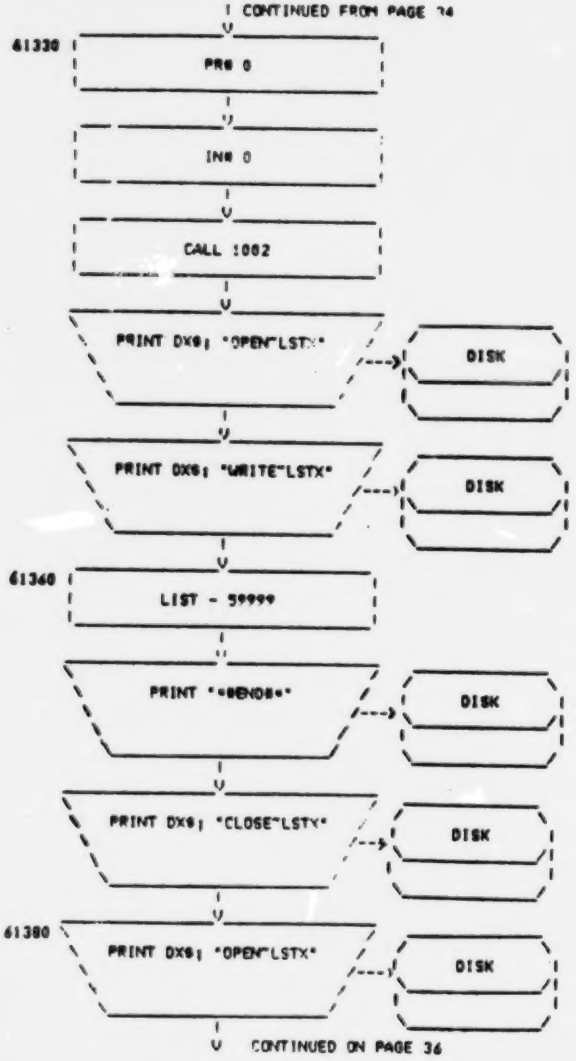

CONTINUED FROM PAGE 30
CALL 944
60510
IF PEEK (768) < > 65 OR PEE K (769) < > 13
THEN XX = 1
60520
RETURN
60700
AX = 0
XX = 0
YX = 0
WX = 0
IF BX$ = "A"
THEN AX = 1
60710
PRINT BX$
INTERFACE
CALL 944
CONTINUED ON PAGE 32

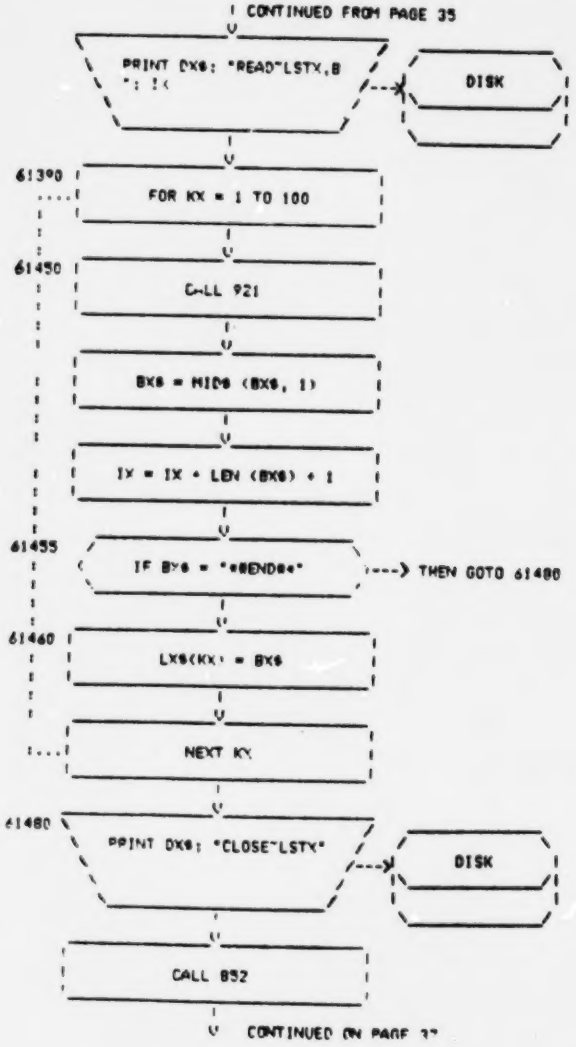

CONTINUED FROM PAGE 31
60730
IX = 767
BX$ = ""
60750
IX = IX + 1
IF IX > 848
THEN XX = 2: GOTO 60840
60760
CX = PEEK (IX)
60780
IF CX < 96 AND CX > 31
THEN GOTO 60800
60790
IF CX < > 13
THEN XX = 3:YX = CX:WX = IX - 767
60800
IF CX = 44
THEN CX = 64
60810
IF CX < > 13
THEN BX$ = BX$ + CHR$ (CX): GOTO 60750
60830
IF LEFT$ (BX$, 2) = "0*"
THEN BX$ = "0*"
60840
IF AX = 0
THEN CX = 0
CONTINUED ON PAGE 33

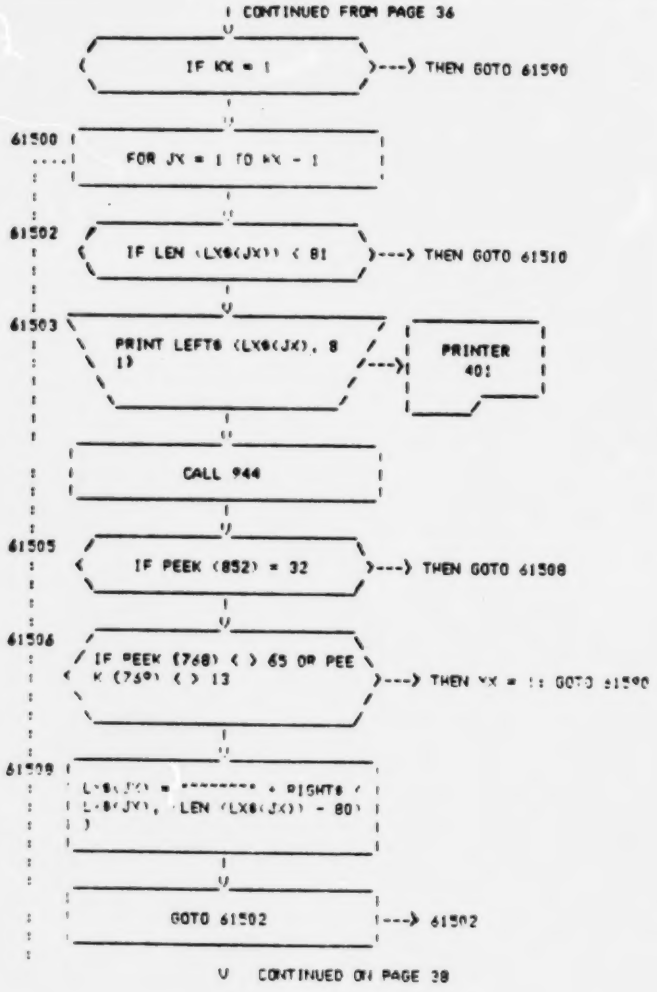


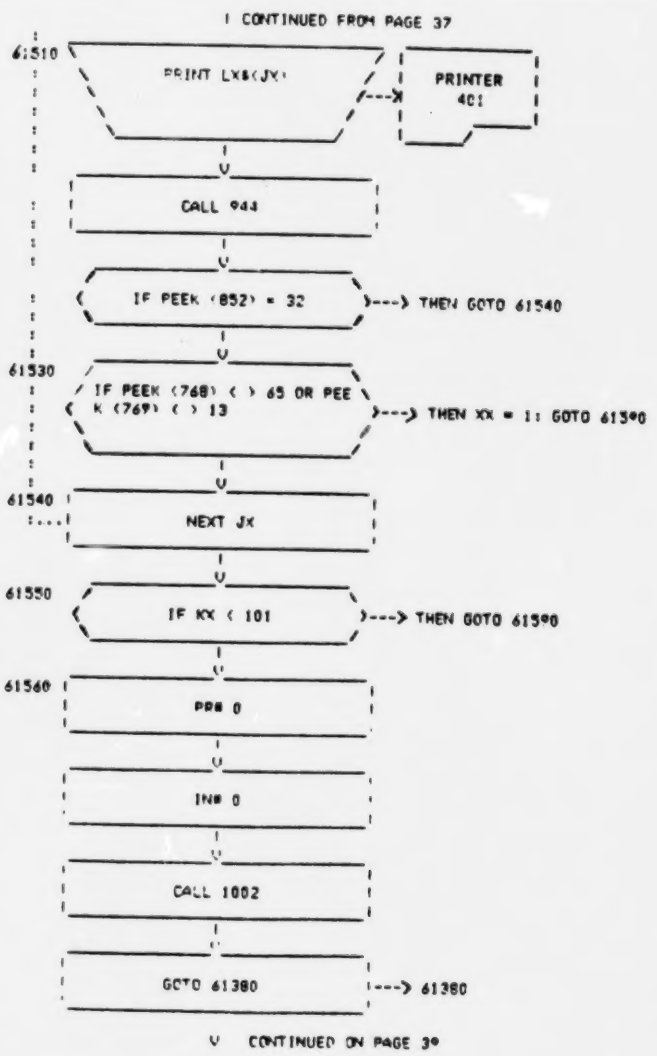


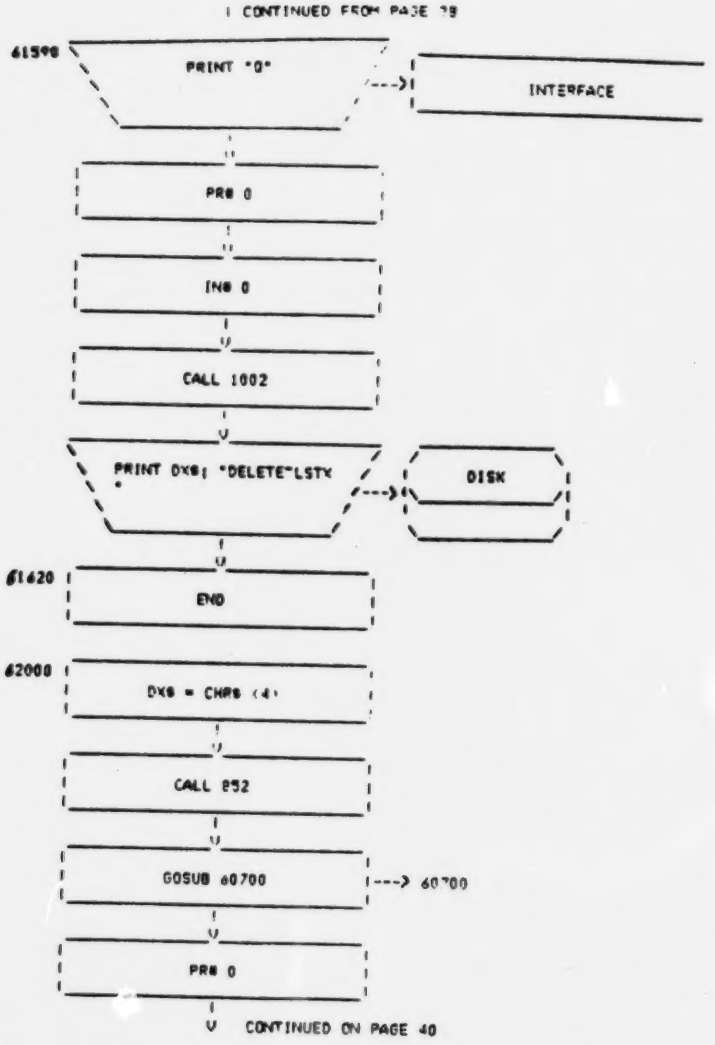
APPENDIX 1. (Cont'd)

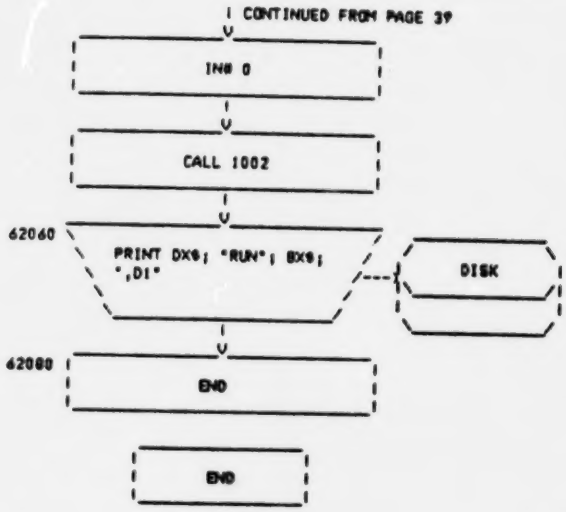

! CONTINUED FROM PAGE 34
61330
PRE 0
INR 0
CALL 1002
PRINT DX$; "OPEN"LSTX"
DISK
PRINT DX$; "WRITE"LSTX"
DISK
61360
LIST - 59999
PRINT "##END##"
DISK
PRINT DX$; "CLOSE"LSTX"
DISK
61380
PRINT DX$; "OPEN"LSTX"
DISK
! CONTINUED ON PAGE 36


! CONTINUED FROM PAGE 35
PRINT DX$; "READ"LSTX,B
": I<
DISK
61390
FOR KX = 1 TO 100
61450
CALL 921
BX$ = MID$ (BX$, I)
IX = IX + LEN (BX$) + 1
61455
IF BX$ = "##END##"
THEN GOTO 61480
61460
LX$(KX) = BX$
NEXT KX
61480
PRINT DX$; "CLOSE"LSTX"
DISK
CALL 852
! CONTINUED ON PAGE 37


! CONTINUED FROM PAGE 36
IF KX = 1
THEN GOTO 61590
61500
FOR JX = 1 TO KX - 1
61502
IF LEN (LX$(JX)) < 81
THEN GOTO 61510
61503
PRINT LEFT$ (LX$(JX), 8
1)
PRINTER
401
CALL 944
61505
IF PEEK (852) = 32
THEN GOTO 61508
61506
IF PEEK (768) < > 65 OR PEE
K (769) < > 13
THEN XX = 1: GOTO 61590
61508
LX$(JX) = "" + RIGHT$ (
LX$(JX), LEN (LX$(JX)) - 80)
)
GOTO 61502
61502
! CONTINUED ON PAGE 38


! CONTINUED FROM PAGE 37
61510
PRINT LX$(JX)
PRINTER
401
CALL 944
IF PEEK (852) = 32
THEN GOTO 61540
61530
IF PEEK (768) < > 65 OR PEE
K (769) < > 13
THEN XX = 1: GOTO 61590
61540
NEXT JX
61550
IF KX < 101
THEN GOTO 61590
61560
PR# 0
IN# 0
CALL 1002
GOTO 61380
61380
! CONTINUED ON PAGE 39


(CONTINUED FROM PAGE 38
61590
PRINT "0"
INTERFACE
PR# 0
IN# 0
CALL 1002
PRINT DX$; "DELETE"LSTX
DISK
61620
END
62000
DX$ = CHR$ (4)
CALL 852
GOSUB 60700
---> 60700
PR# 0
CONTINUED ON PAGE 40


(CONTINUED FROM PAGE 39
IN# 0
CALL 1002
62060
PRINT DX$; "RUN"; BX$;
",D1"
DISK
62080
END
END

```
40    REM     ************************************************
50    REM      **PROGRAM:VISTASUMMARY-   READS DATA ON DISK 2 ***
60    REM     *AND STORES SELECTED PEAK AREAS ON DISK SUMMARY**
70    REM     ************************************************
71    DATA  "001","002","003","004","005","006","007","008","009",
      "010"
72    DATA  "011","012","013","014","015","016","017","018","019",
      "020"
73    DATA  "021","022","023","024","025","026","027","028","029",
      "030"
74    DATA  "031","032","033","034","035","036","037","038","039",
      "040"
75    DATA  "041","042","043","044","045","046","047","048","049",
      "050"
76    DATA  "051","052","053","054","055","056","057","058","059",
      "060"
77    DATA  "061","062","063","064","065","066","067","068","069",
      "070"
78    DATA  "071","072","073","074","075","076","077","078","079",
      "080"
79    DATA  "081","082","083","084","085","086","087","088","089",
      "090"
80    DATA  "091","092","093","094","095","096","097","098","099",
      "100"
81    DATA  "101","102","103","104","105","106","107","108","109",
      "110"
82    DATA  "111","112","113","114","115","116","117","118","119",
      "120"
83    DATA  "121","122","123","124","125","126","127","128","129",
      "130"
84    DATA  "131","132","133","134","135","136","137","138","139",
      "140"
85    DATA  "141","142","143","144","145","146","147","148","149",
      "150"
86    DATA  "151","152","153","154","155","156","157","158","159",
      "160"
87    DATA  "161","162","163","164","165","166","167","168","169",
      "170"
88    DATA  "171","172","173","174","175","176","177","178","179",
      "180"
89    DATA  "181","182","183","184","185","186","187","188","189",
      "190"
90    DATA  "191","192","193","194","195","196","197","198","199",
      "200"
95    ONERR GOTO 1500
100   DIM AR(200, 2), RT(200, 2), LL(2), UL(2), CF(2), R(200),
      SA(200, 2), SR(200, 2), MA(2), T(200), EL(200), FS(2),
      TA(200, 2), TP(200, 2)
130   NM$ = "SUMMARIES"
    : HOME
    : VTAB 4
    : PRINT SPC(9);"APPLE IIE PLUS STORAGE"
220   VTAB 6
    : PRINT SPC(10);"SEARCH OF DATA FILES FOR"
230   VTAB 8
    : PRINT SPC(8);"SELECTION OF PEAKS: SUMMARY"
```



```
240   VTAB 10
    : PRINT SPC(10);"SAVED ON DISK"
    : VTAB 12
    : PRINT SPC(10);"PROGRAM: ";NM$
263   PRINT "IN THE FOLLOWING; 0=NO, 1=YES"
265   INPUT "IS THIS A DUAL PROCEDURE?";R1
272   INPUT "WERE BOTH CELLS USED?";R2
276   INPUT "INPUT NUMBER OF CYCLES (LAST DISK FILE #)?";NC
277   INPUT "VOLUME (ML) OF GC LOOP:";DV
281   VTAB 20
    : INPUT "LOWER LIMIT FOR RETENTION TIME ON SAMPLE CELL #1?";LL(1)
282   INPUT "UPPER LIMIT FOR RETENTION TIME ON SAMPLE CELL
      #1?";UL(1)
283   IF R2 < > 1
        GOTO 288
284   INPUT "LOWER LIMIT FOR RETENTION TIME ON SAMPLE CELL
      #2?";LL(2)
286   INPUT "UPPER LIMIT FOR RETENTION TIME ON SAMPLE CELL
      #2?";UL(2)
288   INPUT "CALIBRATION FACTOR (COUNTS PER NG) OF DETECTOR #1 AND
      DETECTOR #2?";CF(1), CF(2)
289   CT = 1
    : DX = 1
    : FS(1) = "1"
    : FS(2) = "2"
    : SN = 1
    : HOME
290       FOR JC = 1 TO NC
292           FOR K = 1 TO 2
293           : AR(JC, K) = 0
              : SA(JC, K) = 0
              : TA(JC, K) = 0
              : RT(JC, K) = 0
              : SR(JC, K) = 0
              : EL(JC) = 0
              : TP(JC, K) = 0
297           NEXT K
        : NEXT JC
301       FOR RN = 1 TO NC
302           FOR N = 1 TO 100
              : R(N) = 0
              : T(N) = 0
              : NEXT N
306       ET = 0
        : GOSUB 960
        : GOSUB 1200
        : IF R1 < > 1
            GOTO 319
313       IF CT = 2
            GOTO 318
314       CT = 2
        : DX = 2
        : RN = RN + 1
        : GOTO 302
318       CT = 1
        : DX = 1
        : GOTO 320
```

APPENDIX 2.

Listing and Flowchart of VISTASUMMARY.

```
310         READ N$
          : RN = RN + 1
320         SN = SN + 1
          : NEXT RN
325   CT = 1
    : SN = SN - 1
340   VTAB 14
    : PRINT SPC(39);
    : HTAB 11
    : FLASH
    : PRINT CHR$(7);"SAVING SUMMARIES ON DISK"
    : NORMAL
    : D$ = CHR$(4)
450   MA(1) = AR(1, 1)
452         FOR J = 2 TO SN
          : IF AR(J, 1) < MA(1)
              GOTO 455
454         MA(1) = AR(J, 1)
455         NEXT J
456   IF R2 < > 1
        THEN 470
457   MA(2) = AR(1, 2)
458         FOR J = 2 TO SN
          : IF AR(J, 2) < MA(2)
              GOTO 461
460         MA(2) = AR(J, 2)
461         NEXT J
470   PRINT D$;"OPEN SUMMARY"B$ + F$(DX) + B$
    : PRINT D$;"WRITE SUMMARY"B$ + F$(DX)
475   DF = CF(DX)
480   PRINT DX
    : PRINT SN
    : PRINT MA(1)
    : PRINT MA(2)
    : PRINT DF
    : PRINT GU
490         FOR J = 1 TO SN
          : PRINT EL(J)
          : PRINT AR(J, 1)
          : NEXT J
500   IF R2 < > 1
        GOTO 530
510         FOR J = 1 TO SN
          : PRINT EL(J)
          : PRINT AR(J, 2)
          : NEXT J
530   PRINT D$;"CLOSE SUMMARY"B$ + F$(DX)
    : IF R1 < > 1
        GOTO 614
551   IF CT = 2
        GOTO 602
552   DX = 2
    : CT = 2
553         FOR TC = 1 TO SN
          : TA(TC, 1) = AR(TC, 1)
          : AR(TC, 1) = SA(TC, 1)
```



```
556   IF R2 < > 1
        GOTO 600
557         FOR TC = 1 TO SN
          : TA(TC, 2) = AR(TC, 2)
          : AR(TC, 2) = SA(TC, 2)
          : NEXT TC
600   GOTO 450
602         FOR TC = 1 TO SN
          : AR(TC, 1) = TA(TC, 1)
          : NEXT TC
605   IF R2 < > 1
        GOTO 614
610         FOR TC = 1 TO SN
          : AR(TC, 2) = TA(TC, 2)
          : NEXT TC
614   VTAB 14
    : PRINT SPC(39);
    : HTAB 11
    : FLASH
    : PRINT CHR$(7);"PRINTING RESULTS FOR HARDCOPY"
    : NORMAL
615   PR# 1
    : PRINT CHR$(9);"80N"
    : PRINT "FOR THE FIRST CELL ON DAY:";MO;"YEAR:";YR
    : GOSUB 1300
625         FOR J = 1 TO SN
630         PRINT J;
          : POKE 36, 13
          : PRINT PT(J, 1);
          : POKE 36, 31
          : PRINT AR(J, 1);
          : POKE 36, 48
          : PRINT AR(J, 1) / ((CF(1) * GU));
          : POKE 36, 68
          : PRINT EL(J)
631         IF R1 < > 1
              GOTO 635
634         PRINT J;
          : POKE 36, 13
          : PRINT SR(J, 1);
          : POKE 36, 31
          : PRINT SA(J, 1);
          : POKE 36, 48
          : PRINT SA(J, 1) / ((CF(2) * GU));
          : POKE 36, 68
          : PRINT EL(J)
635         PRINT ""
          : NEXT J
650   PRINT ""
    : PRINT ""
    : IF R2 < > 1
        GOTO 69"
665   PRINT "FOR THE SECOND CELL"
    : GOSUB 1300
675         FOR J = 1 TO SN
```

```
680         PRINT J;
          : POKE 36, 13
          : PRINT RT(J, 2);
          : POKE 36, 31
          : PRINT AR(J, 2);
          : POKE 36, 48
          : PRINT AR(J, 2) /(((CF(1) * GV));
          : POKE 36, 68
          : PRINT EL(J)
681         IF R1 < > 1
              GOTO 685
684         PRINT J;
          : POKE 36, 13
          : PRINT SR(J, 2);
          : POKE 36, 31
          : PRINT SA(J, 2);
          : POKE 36, 48
          : PRINT SA(J, 2) /(((CF(2) * GV));
          : POKE 36, 68
          : PRINT EL(J)
685         PRINT "
          : NEXT J
695     PRINT "
      : PRINT "
697     POKE 54, 7
      : POKE 55, 195
      : CALL 1002
      : END
960     REM    ***SUBROUTINE TO READ DISK****
961     B$ = ",D2"
      : D$ = CHR$(4)
      : IF RN > 100
          THEN B$ = ",D1"
973     O$ = "OPEN"CYCLE"B$"
      : W$ = "WRITE"CYCLE"B$"
      : C$ = "CLOSE"CYCLE"B$"
      : R$ = "READ"CYCLE"B$"
979     I$ = "CYCLE"B$"
      : READ N$
1047    VTAB 14
      : PRINT SPC(19);
      : HTAB 8
      : FLASH
      : PRINT CHR$(7);"READING"RESULTS"FROM"FILE"B$ + N$
      : NORMAL
1050    PRINT D$;O$ + N$ + B$
      : PRINT D$;R$ + N$
      : INPUT RN, NP, ET, MO, YR
1065        FOR L = 1 TO NP
          : INPUT T(L), R(L)
          : NEXT L
      : PRINT D$;C$ + N$
1107    IF RN > 1
          GOTO 1110
1108    ES = ET
1110    RETURN
```



```
1200    REM    *****SUBROUTINE TO FIND SELECTED PEAKS *****
1205        FOR J = 1 TO NP
          : IF T(J) < LL(1)
              GOTO 1263
1215        IF T(J) > UL(1)
              GOTO 1235
1218        IF DX = 2
              GOTO 1231
1220        RT(SN, 1) = T(J)
          : AR(SN, 1) = R(J)
          : GOTO 1263
1231        SR(SN, 1) = T(J)
          : SA(SN, 1) = R(J)
          : GOTO 1263
1235        IF R2 < > 1
              GOTO 1263
1240        IF T(J) < LL(2)
              GOTO 1263
1245        IF T(J) > UL(2)
              GOTO 1263
1248        IF DX = 2
              GOTO 1257
1250        RT(SN, 2) = T(J)
          : AR(SN, 2) = R(J)
          : GOTO 1263
1257        SR(SN, 2) = T(J)
          : SA(SN, 2) = R(J)
1263        NEXT J
1266    EL(SN) = ET - ES
      : RETURN
1300    REM    *****SUBROUTINE TO PRINT HEADINGS*****
1305    PRINT "CYCLE"; SPC(6);"RETENTION"TIME"; SPC(7);"PEAK";
        SPC(13);"PEAK"; SPC(10);"ELAPSED"TIME"
1310    PRINT "NO."; SPC(9);"IN"MINUTES"; SPC(6);"AREA(COUNT)";
        SPC(6);"AREA(NG/ML)"; SPC(5);"IN"MINUTES"
      : PRINT "
      : PRINT "
1350    RETURN
1500    POKE 2043, 72
      : LN = PEEK(218) + PEEK(219) * 256
      : EN = PEEK(222)
1515    PRINT "ERROR"CODE:"";EN;"IN"LINE"NUMBER:"";LN
      : POKE 2043, 200
      : END
```

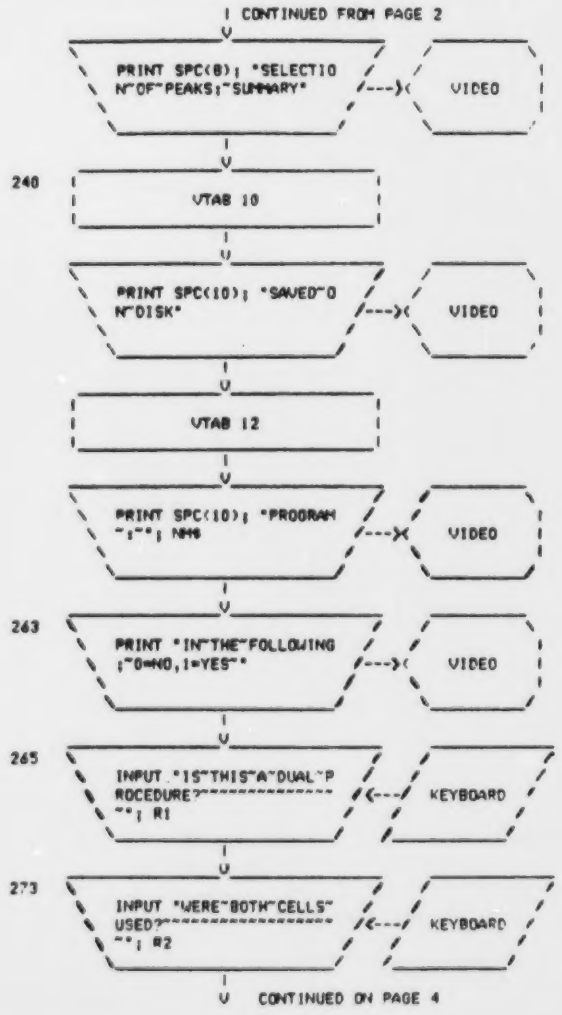
APPENDIX 2. (Cont'd)

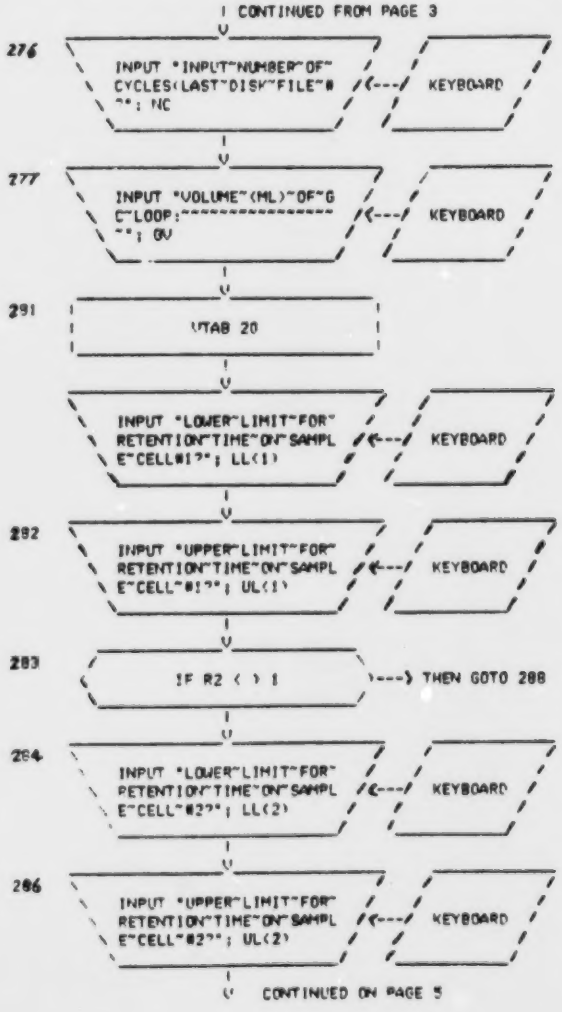
```
                    ┌─────────┐
                    │  START  │
                    └─────────┘
                         │
40                       ├ REM     ********************************
                         ├ **********************
50                       ├ REM      **PROGRAM:VISTASUMMARY-   READS DATA
                         ├ ON DISK 2 ***
60                       ├ REM      *AND STORES SELECTED PEAK AREAS ON
                         ├ DISK (SUMMARY)*
70                       ├ REM      ********************************
                         ├ **********************
71                       ├ DATA   "001","002","003","004","005","006",
                         ├ "007","008","009","010"
72                       ├ DATA   "011","012","013","014","015","016",
                         ├ "017","018","019","020"
73                       ├ DATA   "021","022","023","024","025","026",
                         ├ "027","028","029","030"
74                       ├ DATA   "031","032","033","034","035","036",
                         ├ "037","038","039","040"
75                       ├ DATA   "041","042","043","044","045","046",
                         ├ "047","048","049","050"
76                       ├ DATA   "051","052","053","054","055","056",
                         ├ "057","058","059","060"
77                       ├ DATA   "061","062","063","064","065","066",
                         ├ "067","068","069","070"
78                       ├ DATA   "071","072","073","074","075","076",
                         ├ "077","078","079","080"
79                       ├ DATA   "081","082","083","084","085","086",
                         ├ "087","088","089","090"
80                       ├ DATA   "091","092","093","094","095","096",
                         ├ "097","098","099","100"
81                       ├ DATA   "101","102","103","104","105","106",
                         ├ "107","108","109","110"
82                       ├ DATA   "111","112","113","114","115","116",
                         ├ "117","118","119","120"
83                       ├ DATA   "121","122","123","124","125","126",
                         ├ "127","128","129","130"
84                       ├ DATA   "131","132","133","134","135","136",
                         ├ "137","138","139","140"
85                       ├ DATA   "141","142","143","144","145","146",
                         ├ "147","148","149","150"
86                       ├ DATA   "151","152","153","154","155","156",
                         ├ "157","158","159","160"
87                       ├ DATA   "161","162","163","164","165","166",
                         ├ "167","168","169","170"
88                       ├ DATA   "171","172","173","174","175","176",
                         ├ "177","178","179","180"
89                       ├ DATA   "181","182","183","184","185","186",
                         ├ "187","188","189","190"
90                       ├ DATA   "191","192","193","194","195","196",
                         ├ "197","198","199","200"
                           CONTINUED ON PAGE 2
```

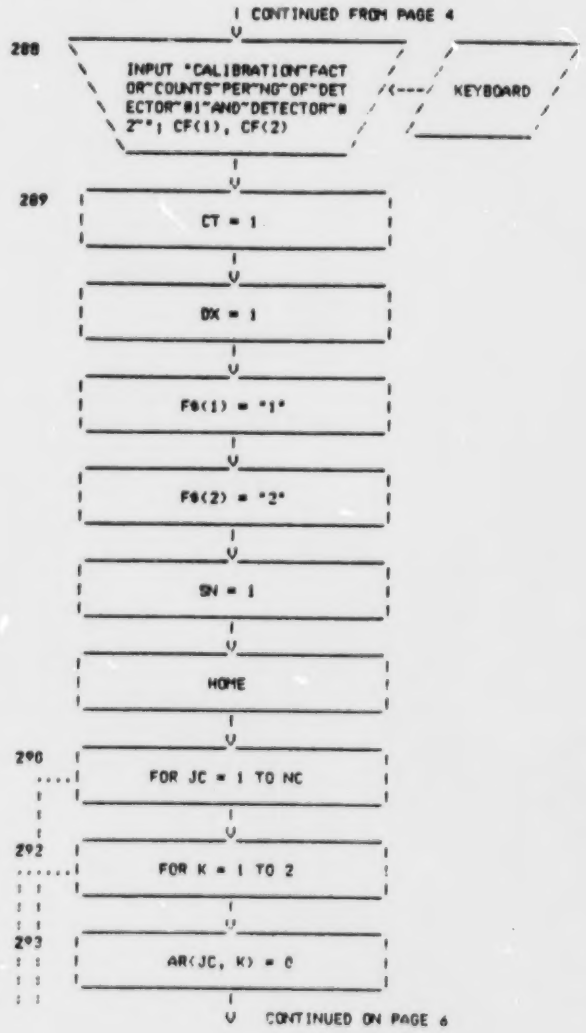

CONTINUED FROM PAGE 1

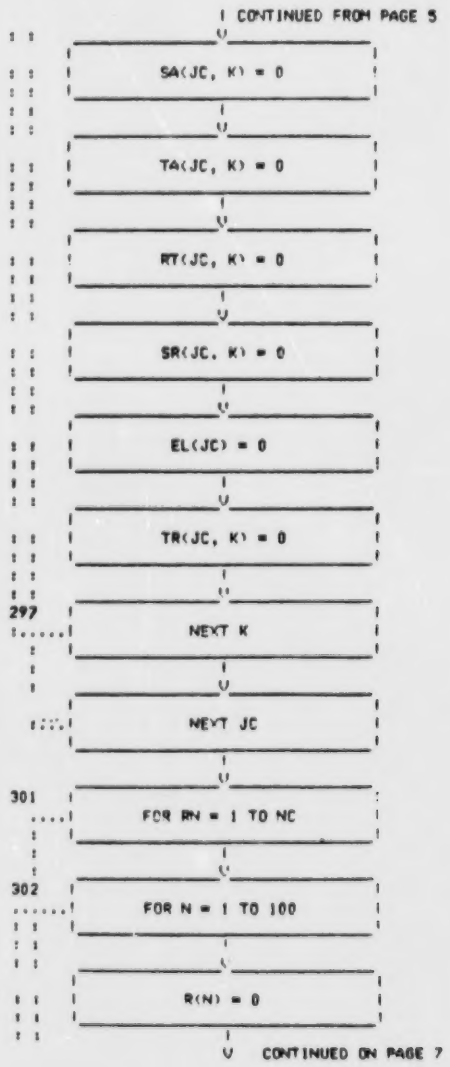
```
                         ∨
98                  ┌──────────────────┐
                    │ ONERR GOTO 1500  │ ---) 1500
                    └──────────────────┘

                    ┌──────────────────┐
100                 │ DIM AR(200, 2), RT(200, 2), L
                    │ L(2), UL(2), CF(2), R(200), S
                    │ A(200, 2), SR(200, 2), MA(2),
                    │  T(200), EL(200), FB(2), TA(2
                    │ 00, 2), TR(200, 2)
                    └──────────────────┘
                         ∨
                    ┌──────────────────┐
130                 │ NM$ = "SUMMARIES"
                    └──────────────────┘
                         ∨
                    ┌──────────────────┐
                    │      HOME        │
                    └──────────────────┘
                         ∨
                    ┌──────────────────┐
                    │     VTAB 4       │
                    └──────────────────┘
                         ∨
                    ┌──────────────────┐
                    │ PRINT SPC(9); "APPLE"II
                    │ "PLUS"STORAGE"   │ ---)( VIDEO
                    └──────────────────┘
                         ∨
                    ┌──────────────────┐
220                 │     VTAB 6       │
                    └──────────────────┘
                         ∨
                    ┌──────────────────┐
                    │ PRINT SPC(10); "SEARCH"
                    │ OF"DATA"FILES"FOR"  │ ---)( VIDEO
                    └──────────────────┘
                         ∨
                    ┌──────────────────┐
230                 │     VTAB 8       │
                    └──────────────────┘
                         ∨
```

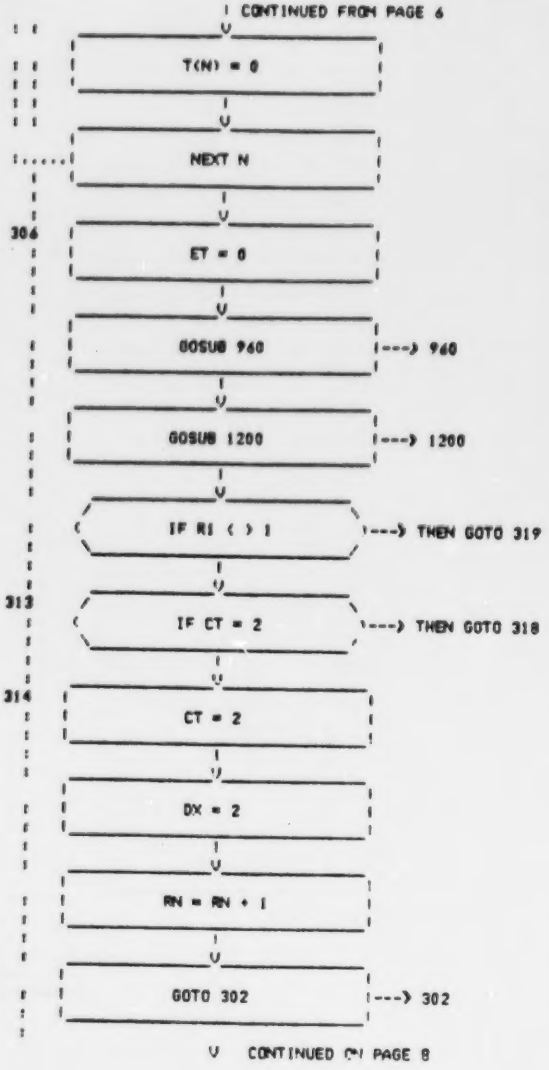
CONTINUED ON PAGE 3

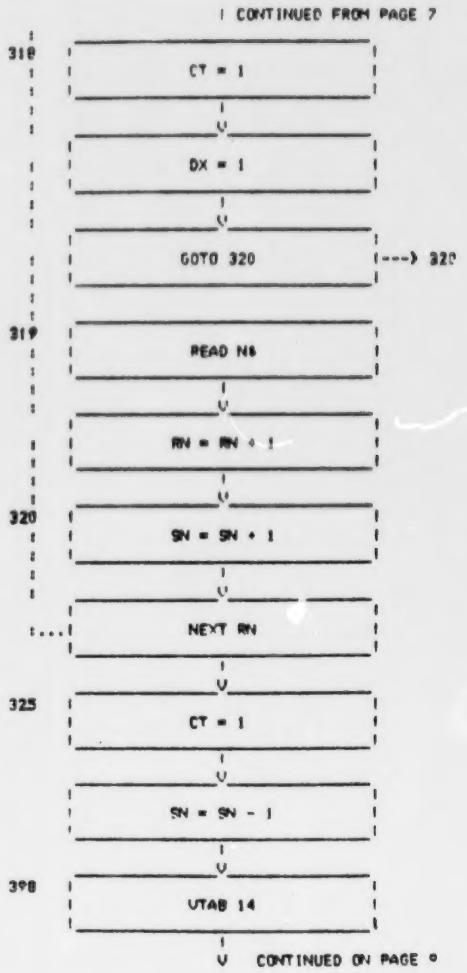

! CONTINUED FROM PAGE 2
PRINT SPC(8); "SELECTIO N"OF"PEAKS;"SUMMARY"
VIDEO
240
VTAB 10
PRINT SPC(10); "SAVED"O N"DISK"
VIDEO
VTAB 12
PRINT SPC(10); "PROGRAM "; NM$
VIDEO
263
PRINT "IN"THE"FOLLOWING ;"0=NO,1=YES""
VIDEO
265
INPUT "IS"THIS"A"DUAL"P ROCEDURE?"; R1
KEYBOARD
273
INPUT "WERE"BOTH"CELLS" USED?"; R2
KEYBOARD
CONTINUED ON PAGE 4

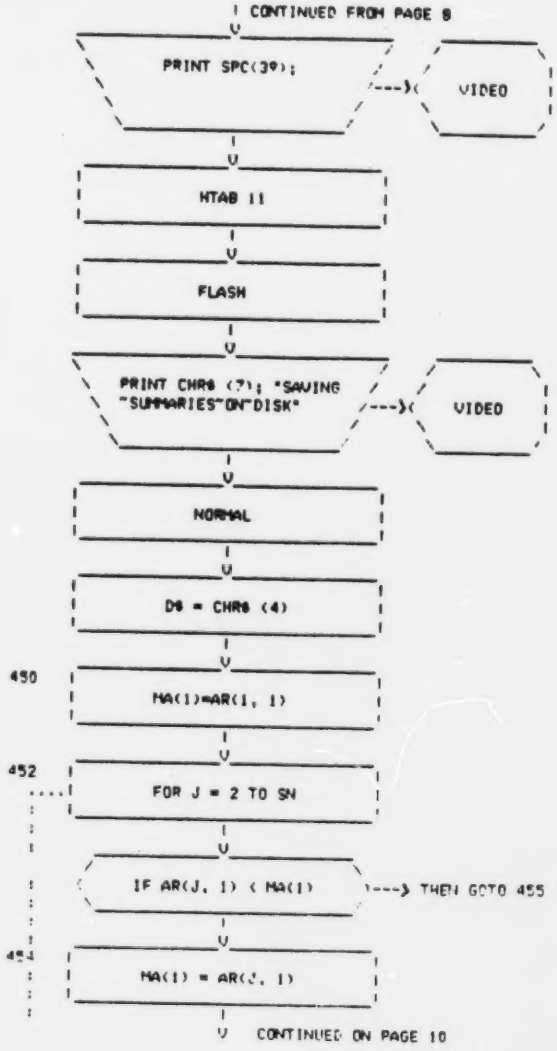

! CONTINUED FROM PAGE 3
276
INPUT "INPUT"NUMBER"OF" CYCLES(LAST"DISK"FILE"# "; NC
KEYBOARD
277
INPUT "VOLUME"(ML)"OF"G C"LOOP;"" ; GV
KEYBOARD
291
VTAB 20
INPUT "LOWER"LIMIT"FOR" RETENTION"TIME"ON"SAMPL E"CELL"#1?"; LL(1)
KEYBOARD
282
INPUT "UPPER"LIMIT"FOR" RETENTION"TIME"ON"SAMPL E"CELL"#1?"; UL(1)
KEYBOARD
283
IF R2 < > 1
THEN GOTO 288
284
INPUT "LOWER"LIMIT"FOR" RETENTION"TIME"ON"SAMPL E"CELL"#2?"; LL(2)
KEYBOARD
286
INPUT "UPPER"LIMIT"FOR" RETENTION"TIME"ON"SAMPL E"CELL"#2?"; UL(2)
KEYBOARD
CONTINUED ON PAGE 5

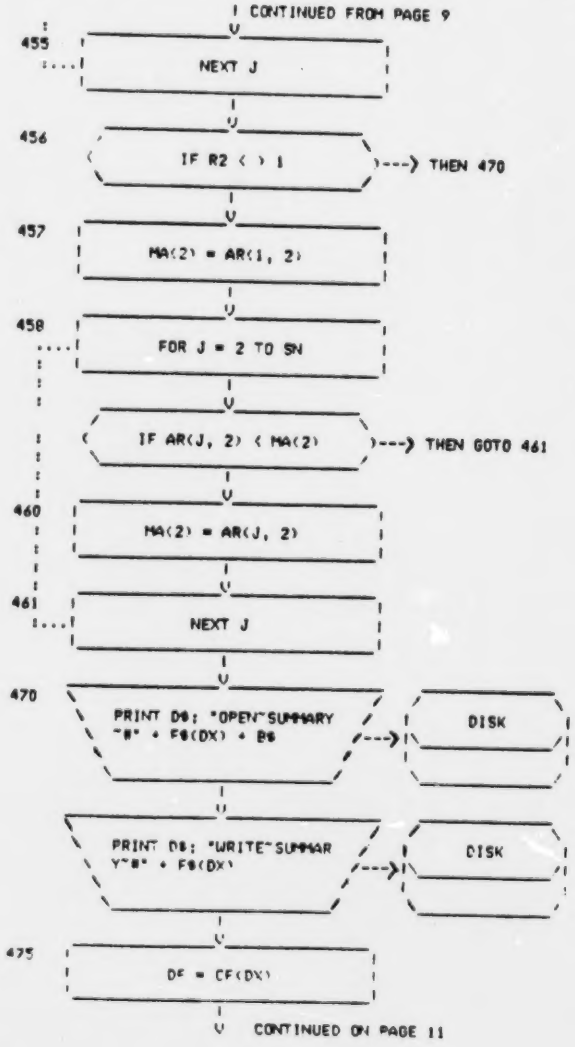

CONTINUED FROM PAGE 4
288
INPUT "CALIBRATION FACTOR COUNTS PER NG OF DETECTOR #1 AND DETECTOR #2"; CF(1), CF(2)
KEYBOARD
289
CT = 1
DX = 1
FS(1) = "1"
FS(2) = "2"
SN = 1
HOME
290
FOR JC = 1 TO NC
292
FOR K = 1 TO 2
293
AR(JC, K) = 0
CONTINUED ON PAGE 6

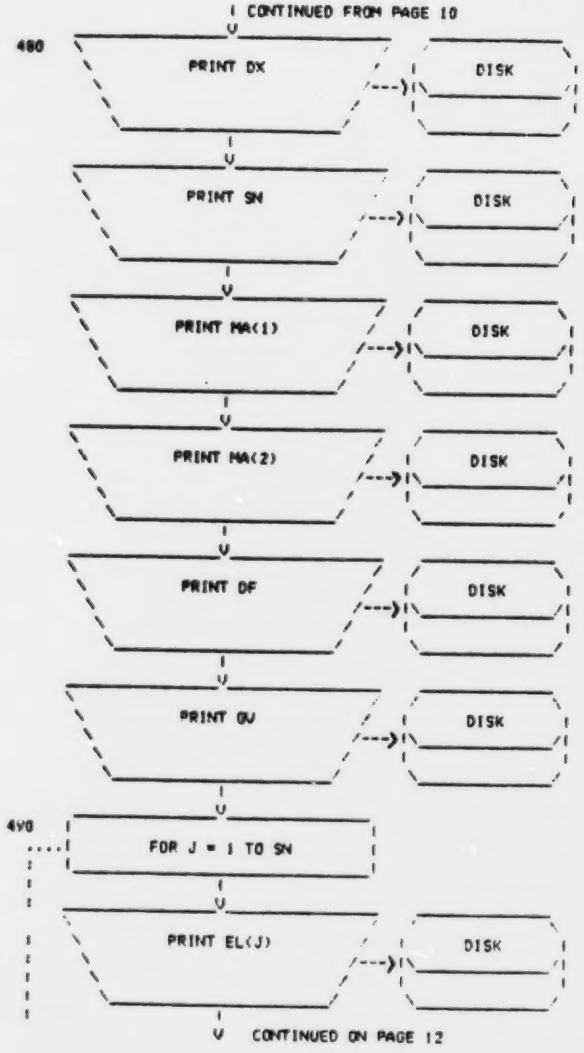

CONTINUED FROM PAGE 5
SA(JC, K) = 0
TA(JC, K) = 0
RT(JC, K) = 0
SR(JC, K) = 0
EL(JC) = 0
TR(JC, K) = 0
297
NEXT K
NEXT JC
301
FOR RN = 1 TO NC
302
FOR N = 1 TO 100
R(N) = 0
CONTINUED ON PAGE 7

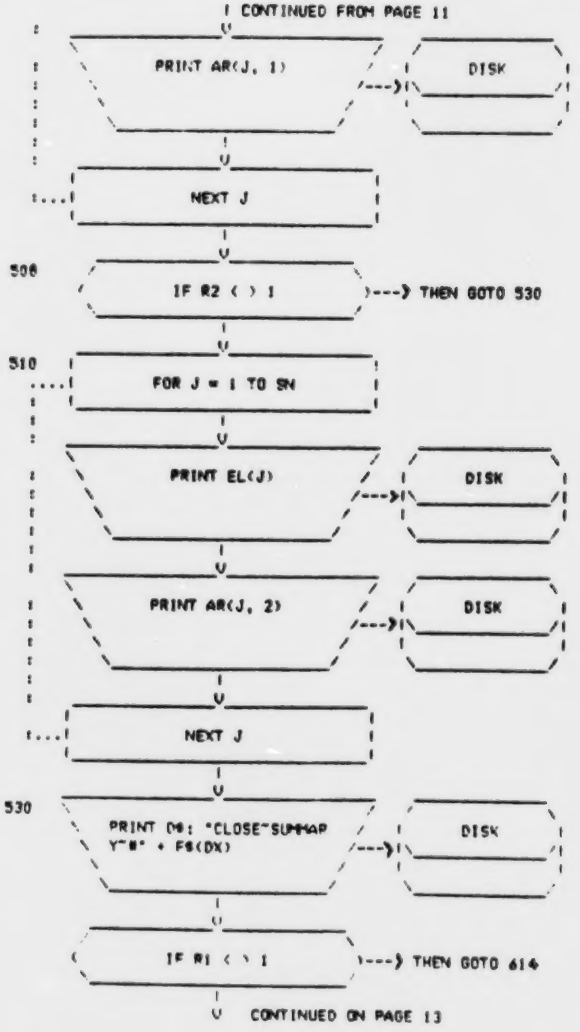

! CONTINUED FROM PAGE 6
T(N) = 0
NEXT N
306
ET = 0
GOSUB 960
---> 960
GOSUB 1200
---> 1200
IF RI ( ) 1
---> THEN GOTO 319
313
IF CT = 2
---> THEN GOTO 318
314
CT = 2
DX = 2
RN = RN + 1
GOTO 302
---> 302
V CONTINUED ON PAGE 8

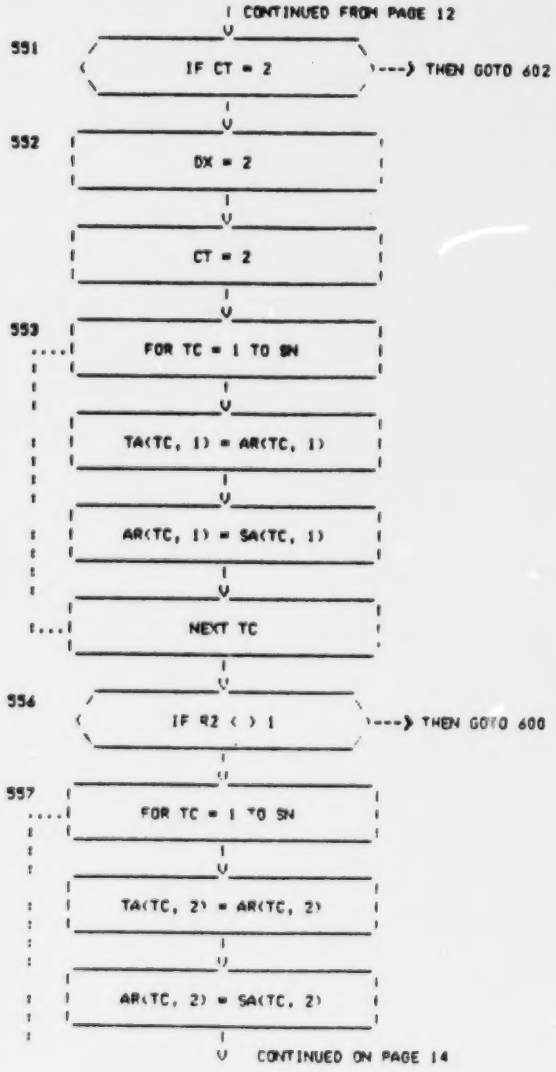

! CONTINUED FROM PAGE 7
318
CT = 1
DX = 1
GOTO 320
---> 320
319
READ N$
RN = RN + 1
320
SN = SN + 1
NEXT RN
325
CT = 1
SN = SN - 1
398
VTAB 14
V CONTINUED ON PAGE 9

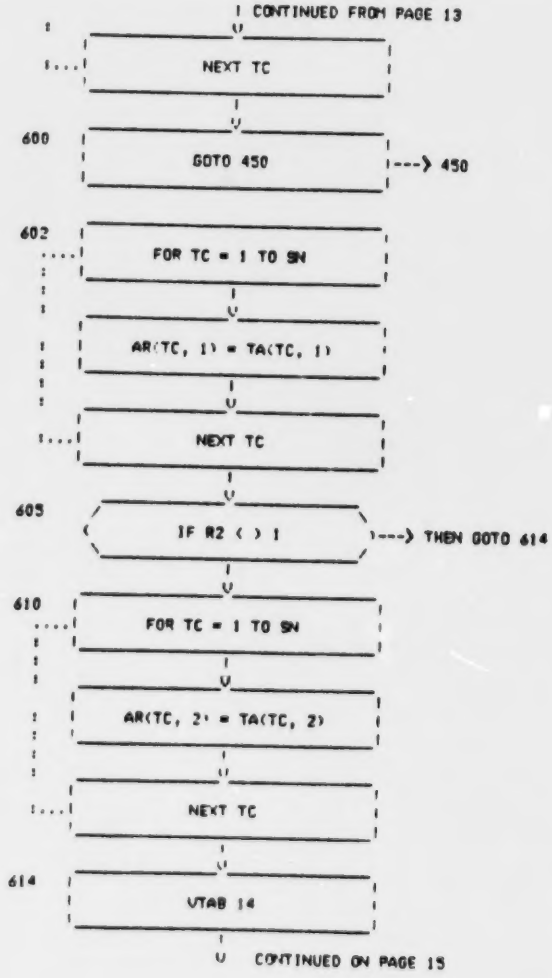

CONTINUED FROM PAGE 8
PRINT SPC(39);
VIDEO
HTAB 11
FLASH
PRINT CHR$ (7); "SAVING "SUMMARIES"ON"DISK"
VIDEO
NORMAL
D$ = CHR$ (4)
450
MA(1)=AR(1, 1)
452
FOR J = 2 TO SN
IF AR(J, 1) < MA(1)
THEN GOTO 455
454
MA(1) = AR(J, 1)
CONTINUED ON PAGE 10

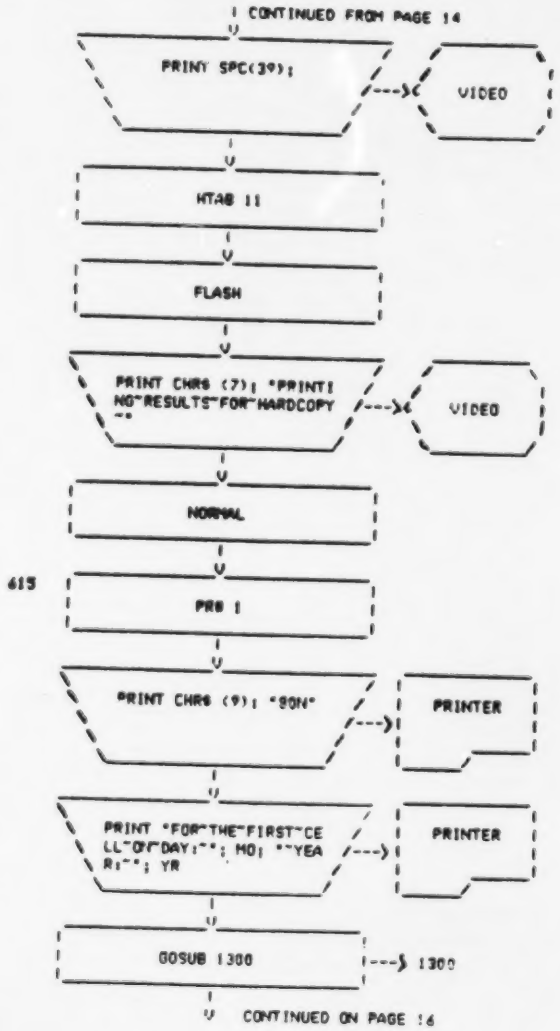

CONTINUED FROM PAGE 9
455
NEXT J
456
IF R2 < > 1
THEN 470
457
MA(2) = AR(1, 2)
458
FOR J = 2 TO SN
IF AR(J, 2) < MA(2)
THEN GOTO 461
460
MA(2) = AR(J, 2)
461
NEXT J
470
PRINT D$; "OPEN"SUMMARY "B" + F$(DX) + B$
DISK
PRINT D$; "WRITE"SUMMAR Y"B" + F$(DX)
DISK
475
DF = CF(DX)
CONTINUED ON PAGE 11

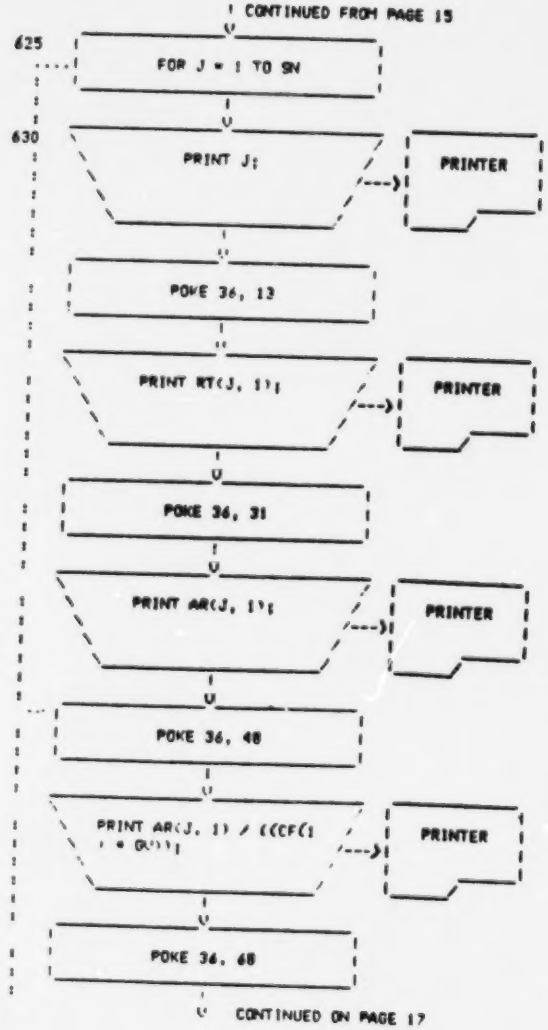

CONTINUED FROM PAGE 10
480
PRINT DX
DISK
PRINT SN
DISK
PRINT MA(1)
DISK
PRINT MA(2)
DISK
PRINT DF
DISK
PRINT OU
DISK
490
FOR J = 1 TO SN
PRINT EL(J)
DISK
CONTINUED ON PAGE 12

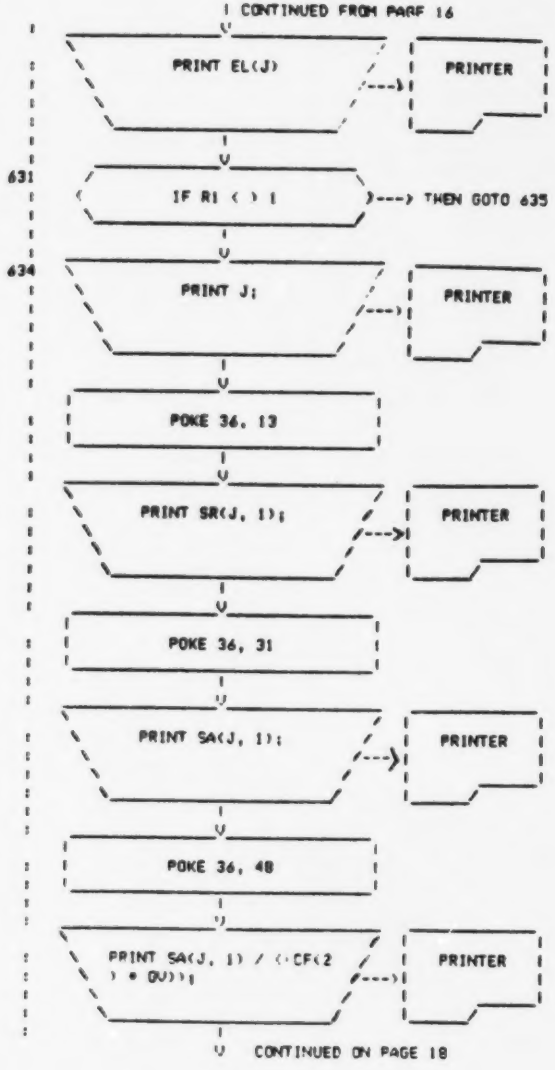

CONTINUED FROM PAGE 11
PRINT AR(J, 1)
DISK
NEXT J
500
IF R2 < > 1
THEN GOTO 530
510
FOR J = 1 TO SN
PRINT EL(J)
DISK
PRINT AR(J, 2)
DISK
NEXT J
530
PRINT D$; "CLOSE"SUMMAR
Y"R" + F$(DX)
DISK
IF R1 < > 1
THEN GOTO 614
CONTINUED ON PAGE 13

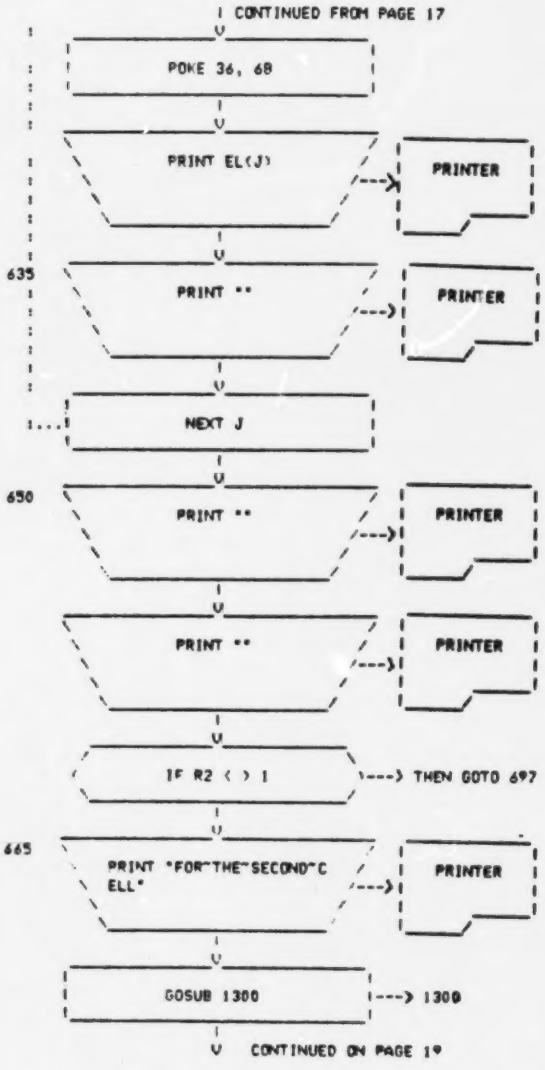

(CONTINUED FROM PAGE 12
551
IF CT = 2
---> THEN GOTO 602
552
DX = 2
CT = 2
553
FOR TC = 1 TO SN
TA(TC, 1) = AR(TC, 1)
AR(TC, 1) = SA(TC, 1)
NEXT TC
556
IF R2 ( ) 1
---> THEN GOTO 600
557
FOR TC = 1 TO SN
TA(TC, 2) = AR(TC, 2)
AR(TC, 2) = SA(TC, 2)
V CONTINUED ON PAGE 14

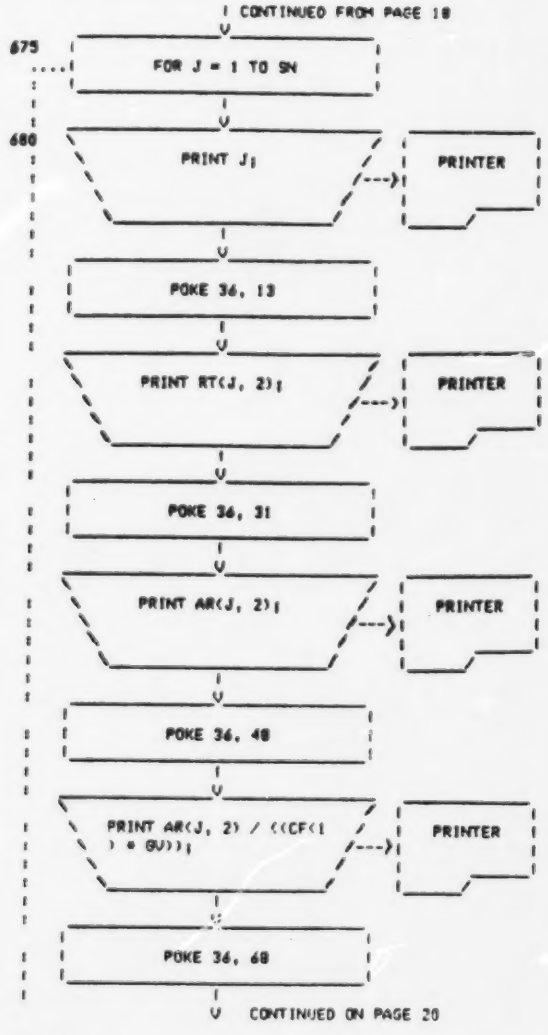

(CONTINUED FROM PAGE 13
NEXT TC
600
GOTO 450
---> 450
602
FOR TC = 1 TO SN
AR(TC, 1) = TA(TC, 1)
NEXT TC
605
IF R2 ( ) 1
---> THEN GOTO 614
610
FOR TC = 1 TO SN
AR(TC, 2) = TA(TC, 2)
NEXT TC
614
VTAB 14
V CONTINUED ON PAGE 15

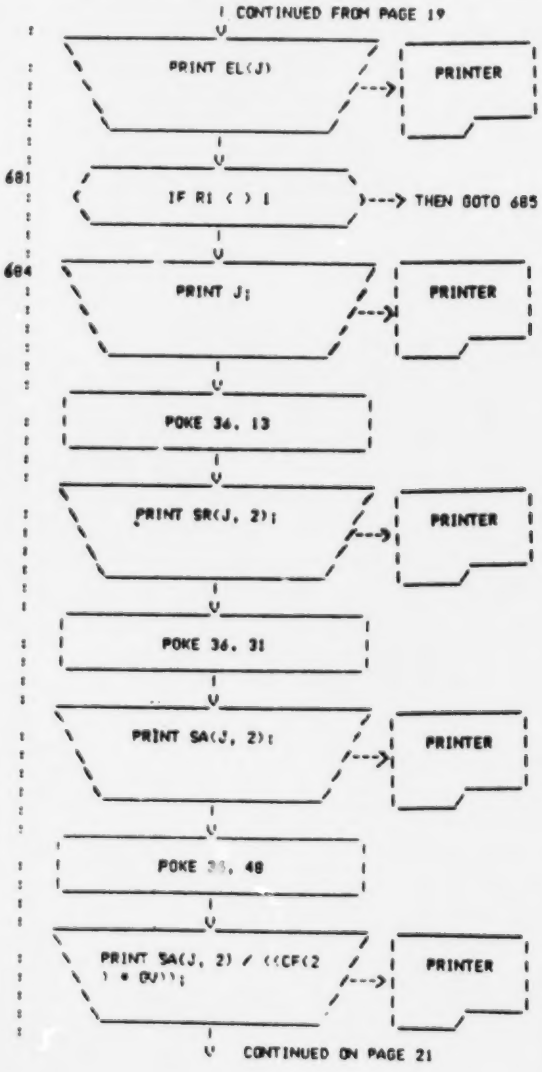

! CONTINUED FROM PAGE 14
PRINT SPC(39);
VIDEO
HTAB 11
FLASH
PRINT CHR$ (7); "PRINT! NO"RESULTS"FOR"HARDCOPY ""
VIDEO
NORMAL
615
PRB 1
PRINT CHR$ (9); "80N"
PRINTER
PRINT "FOR"THE"FIRST"CE LL"OF"DAY:""; MO; ""YEA R:""; YR
PRINTER
GOSUB 1300
1300
CONTINUED ON PAGE 16

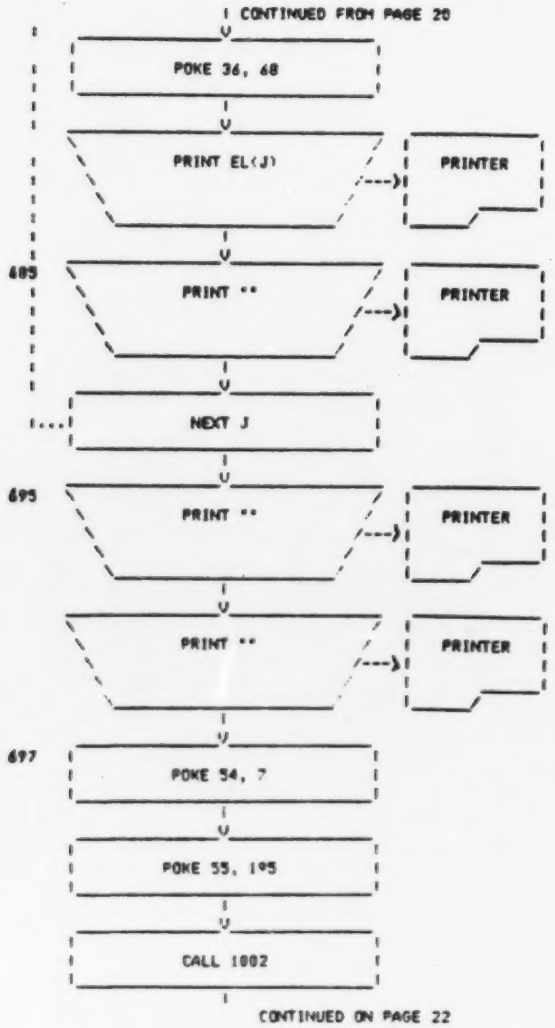

! CONTINUED FROM PAGE 15
625
FOR J = 1 TO SN
630
PRINT J;
PRINTER
POKE 36, 13
PRINT RT(J, 1);
PRINTER
POKE 36, 31
PRINT AR(J, 1);
PRINTER
POKE 36, 48
PRINT AR(J, 1) / (((F(1 + 0))
PRINTER
POKE 36, 68
CONTINUED ON PAGE 17

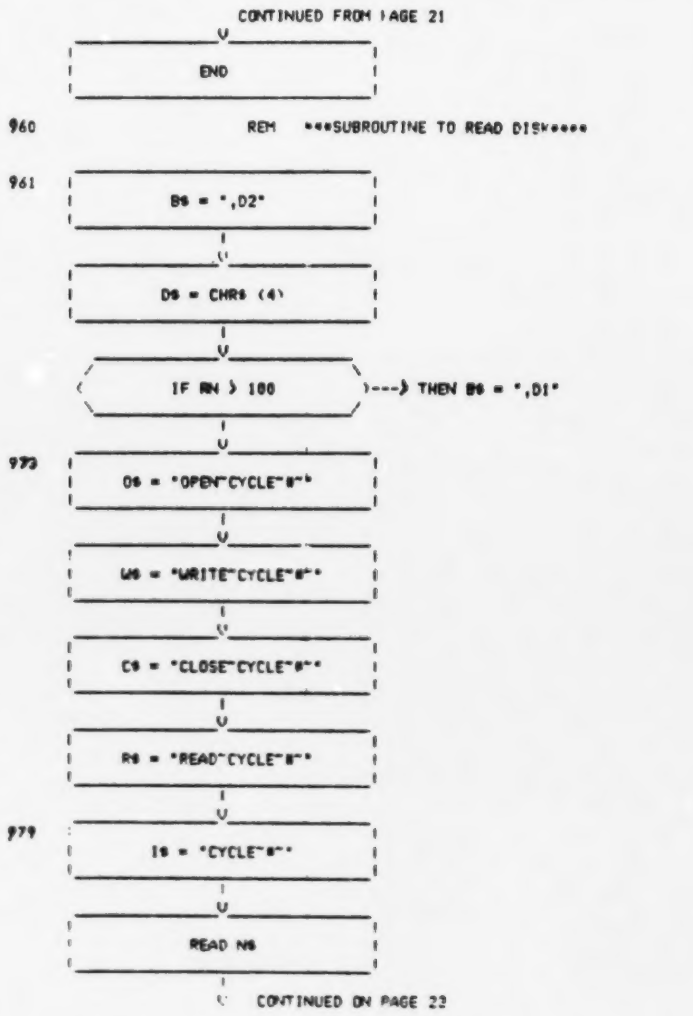

CONTINUED FROM PAGE 16
PRINT EL(J)
PRINTER
631
IF R1 < > 1
THEN GOTO 635
634
PRINT J;
PRINTER
POKE 36, 13
PRINT SR(J, 1);
PRINTER
POKE 36, 31
PRINT SA(J, 1);
PRINTER
POKE 36, 48
PRINT SA(J, 1) / (CF(2
) * QU));
PRINTER
CONTINUED ON PAGE 18

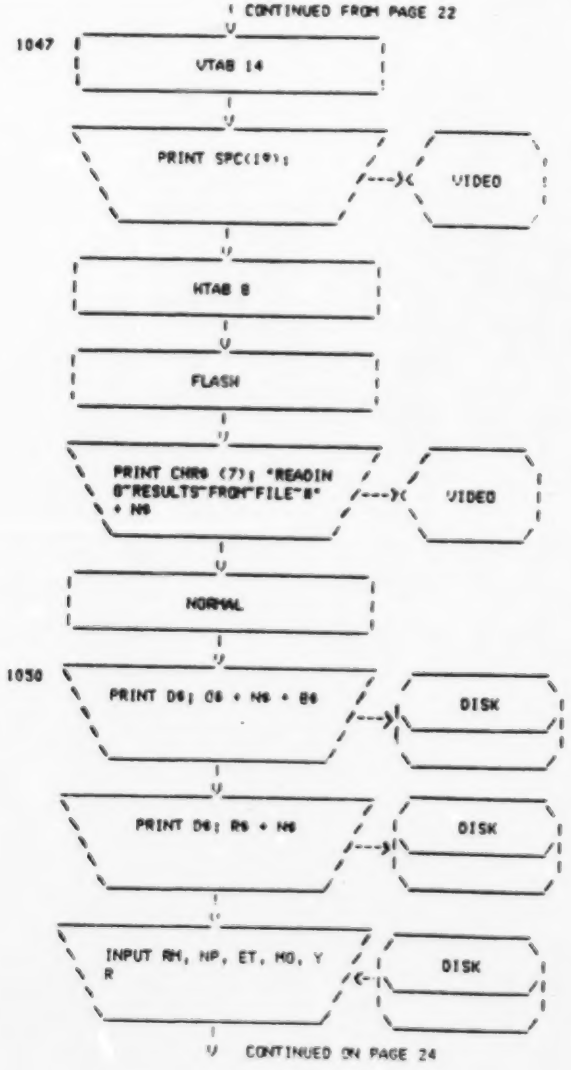

CONTINUED FROM PAGE 17
POKE 36, 68
PRINT EL(J)
PRINTER
635
PRINT **
PRINTER
NEXT J
650
PRINT **
PRINTER
PRINT **
PRINTER
IF R2 < > 1
THEN GOTO 697
665
PRINT "FOR THE SECOND C
ELL"
PRINTER
GOSUB 1300
1300
CONTINUED ON PAGE 19

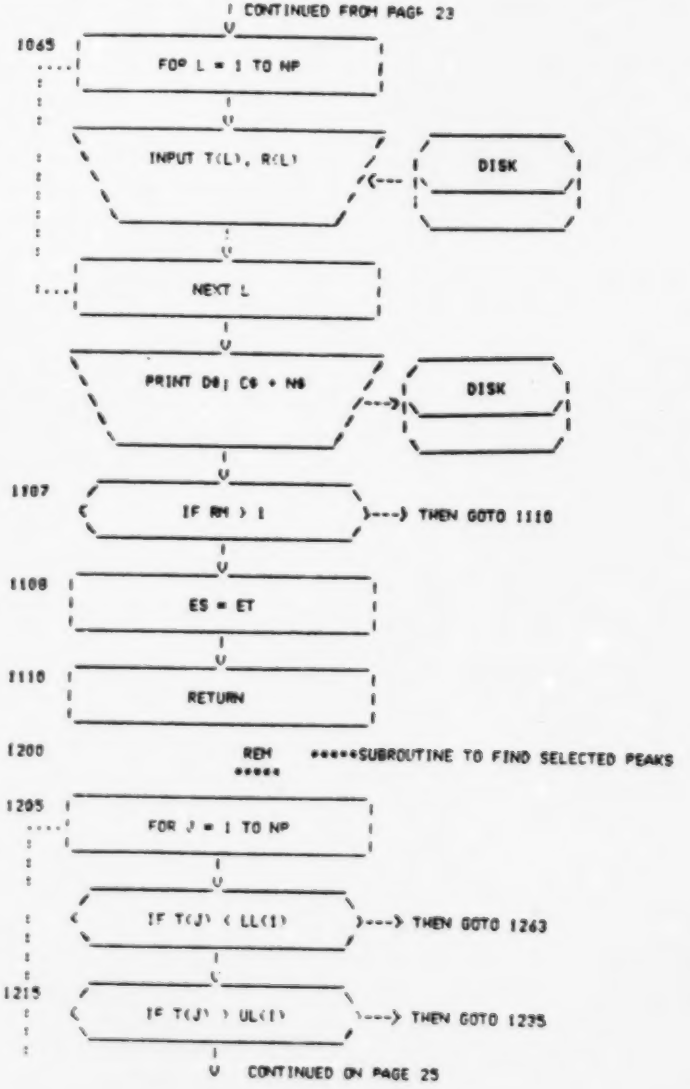

! CONTINUED FROM PAGE 18
675
FOR J = 1 TO SN
680
PRINT J;
PRINTER
POKE 36, 13
PRINT RT(J, 2);
PRINTER
POKE 36, 31
PRINT AR(J, 2);
PRINTER
POKE 36, 48
PRINT AR(J, 2) / ((CF(1
) * GV));
PRINTER
POKE 36, 68
! CONTINUED ON PAGE 20

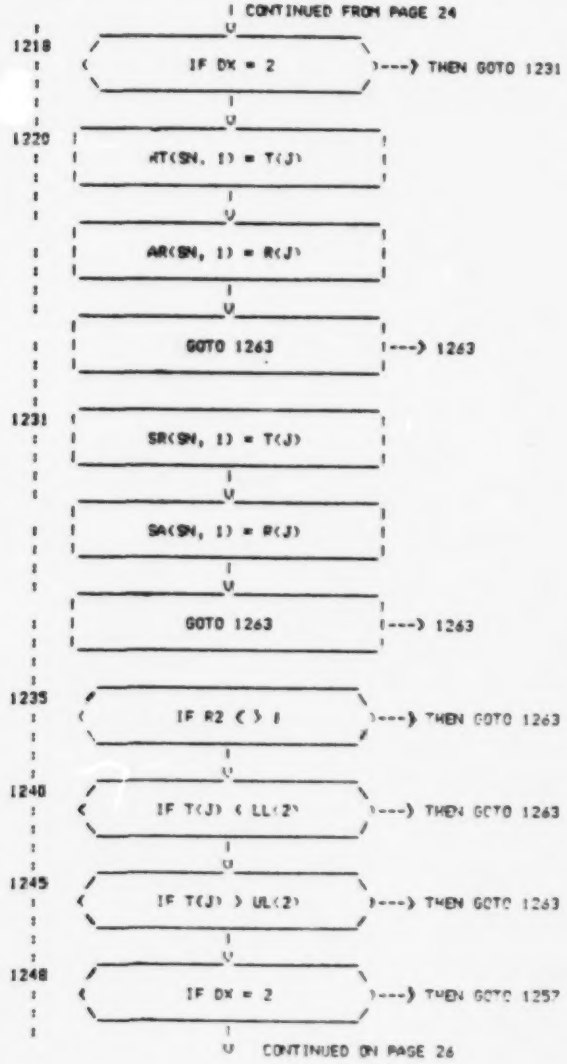

! CONTINUED FROM PAGE 19
PRINT EL(J)
PRINTER
681
IF RI ( ) 1
THEN GOTO 685
684
PRINT J;
PRINTER
POKE 36, 13
PRINT SR(J, 2);
PRINTER
POKE 36, 31
PRINT SA(J, 2);
PRINTER
POKE 36, 48
PRINT SA(J, 2) / ((CF(2
) * GV));
PRINTER
! CONTINUED ON PAGE 21

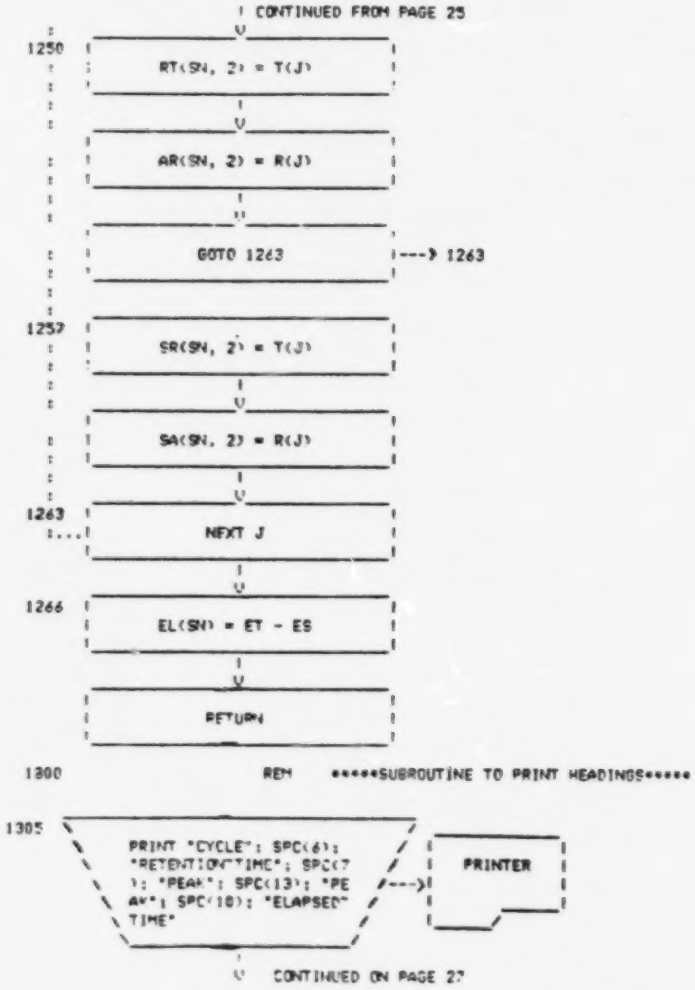

CONTINUED FROM PAGE 20
POKE 36, 68
PRINT EL(J)
PRINTER
485
PRINT ""
PRINTER
NEXT J
495
PRINT ""
PRINTER
PRINT ""
PRINTER
497
POKE 54, 7
POKE 55, 195
CALL 1002
CONTINUED ON PAGE 22

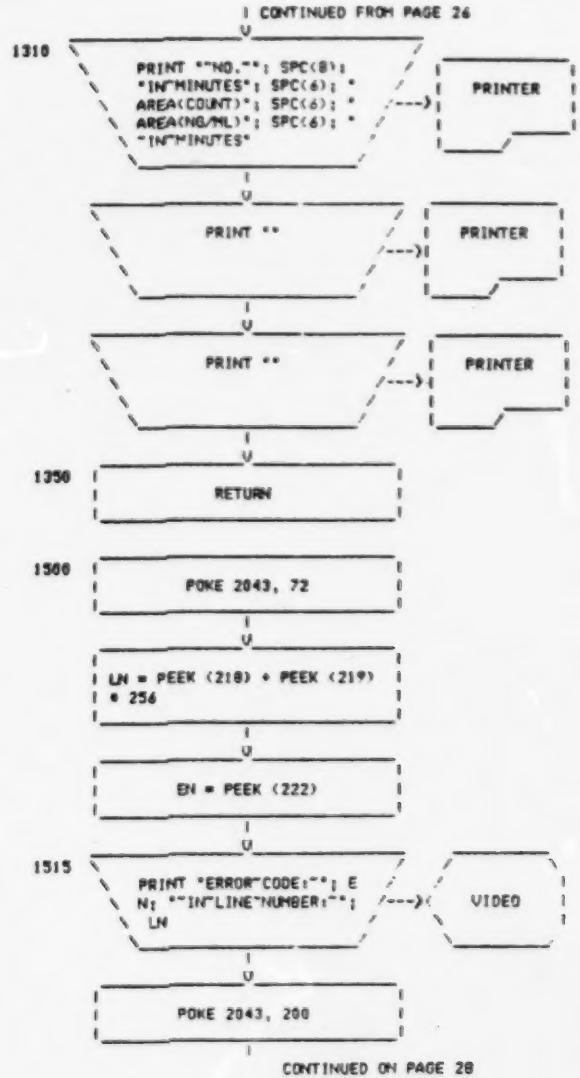

CONTINUED FROM PAGE 21
END
960
REM ***SUBROUTINE TO READ DISK***
961
B$ = ",D2"
D$ = CHR$ (4)
IF RN > 100
THEN B$ = ",D1"
970
O$ = "OPEN"CYCLE"8""
W$ = "WRITE"CYCLE"8""
C$ = "CLOSE"CYCLE"8""
R$ = "READ"CYCLE"8""
979
I$ = "CYCLE"8""
READ N$
CONTINUED ON PAGE 22

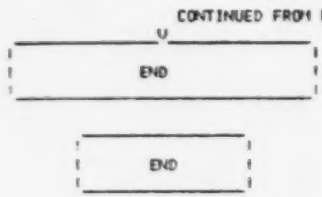

! CONTINUED FROM PAGE 22
1047
VTAB 14
PRINT SPC(19);
VIDEO
HTAB 8
FLASH
PRINT CHR$ (7); "READIN G"RESULTS"FROM"FILE"#" + N$
VIDEO
NORMAL
1050
PRINT D$; C$ + N$ + B$
DISK
PRINT D$; R$ + N$
DISK
INPUT RH, NP, ET, MO, YR
DISK
CONTINUED ON PAGE 24


! CONTINUED FROM PAGE 23
1065
FOR L = 1 TO NP
INPUT T(L), R(L)
DISK
NEXT L
PRINT D$; C$ + N$
DISK
1107
IF RH > 1
THEN GOTO 1110
1108
ES = ET
1110
RETURN
1200
REM *****SUBROUTINE TO FIND SELECTED PEAKS
*****
1205
FOR J = 1 TO NP
IF T(J) < LL(I)
THEN GOTO 1263
1215
IF T(J) > UL(I)
THEN GOTO 1235
CONTINUED ON PAGE 25


! CONTINUED FROM PAGE 24
1218
IF DX = 2
---> THEN GOTO 1231
1220
RT(SN, 1) = T(J)
AR(SN, 1) = R(J)
GOTO 1263
---> 1263
1231
SR(SN, 1) = T(J)
SA(SN, 1) = R(J)
GOTO 1263
---> 1263
1235
IF R2 < > 1
---> THEN GOTO 1263
1240
IF T(J) < LL(2)
---> THEN GOTO 1263
1245
IF T(J) > UL(2)
---> THEN GOTO 1263
1248
IF DX = 2
---> THEN GOTO 1257
CONTINUED ON PAGE 26


! CONTINUED FROM PAGE 25
1250
RT(SN, 2) = T(J)
AR(SN, 2) = R(J)
GOTO 1263
---> 1263
1257
SR(SN, 2) = T(J)
SA(SN, 2) = R(J)
1263
NEXT J
1266
EL(SN) = ET - ES
RETURN
1300
REM *****SUBROUTINE TO PRINT HEADINGS*****
1305
PRINT "CYCLE"; SPC(6); "RETENTION TIME"; SPC(7); "PEAK"; SPC(13); "PEAK"; SPC(10); "ELAPSED TIME"
--->
PRINTER
CONTINUED ON PAGE 27

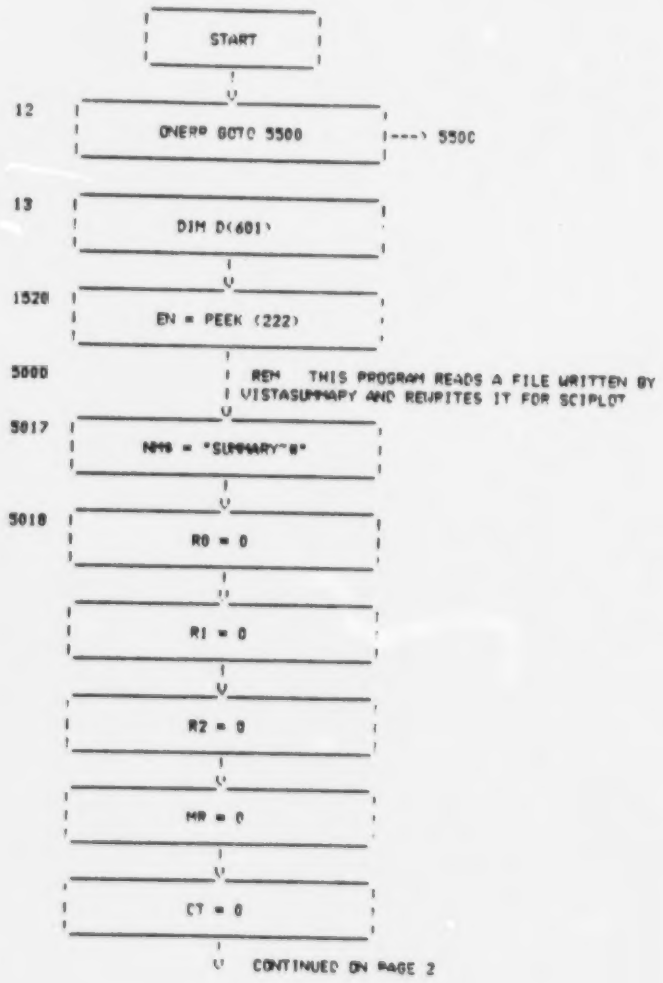

CONTINUED FROM PAGE 26
1310
PRINT ""NO."";SPC(8);
"IN"MINUTES";SPC(6);"
AREA(COUNT)";SPC(6);"
AREA(NG/ML)";SPC(6);"
"IN"MINUTES"
PRINTER
PRINT ""
PRINTER
PRINT ""
PRINTER
1350
RETURN
1500
POKE 2043, 72
LN = PEEK (218) + PEEK (219)
* 256
EN = PEEK (222)
1515
PRINT "ERROR"CODE:"";E
N;""IN"LINE"NUMBER:"";
LN
VIDEO
POKE 2043, 200
CONTINUED ON PAGE 28

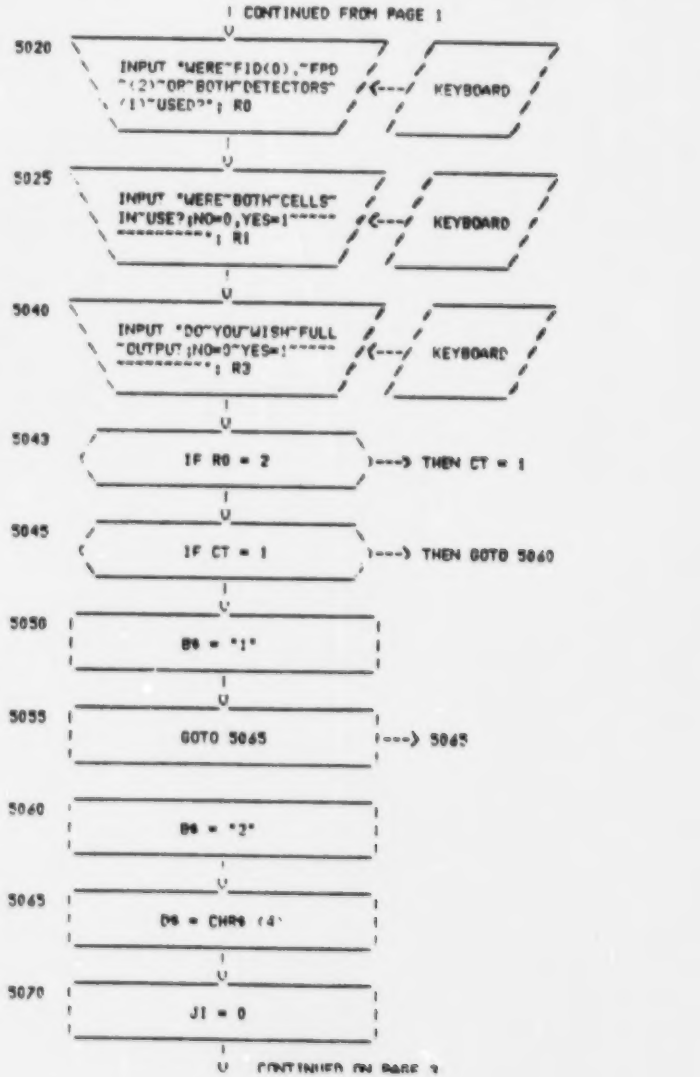

CONTINUED FROM PAGE 27
END
END

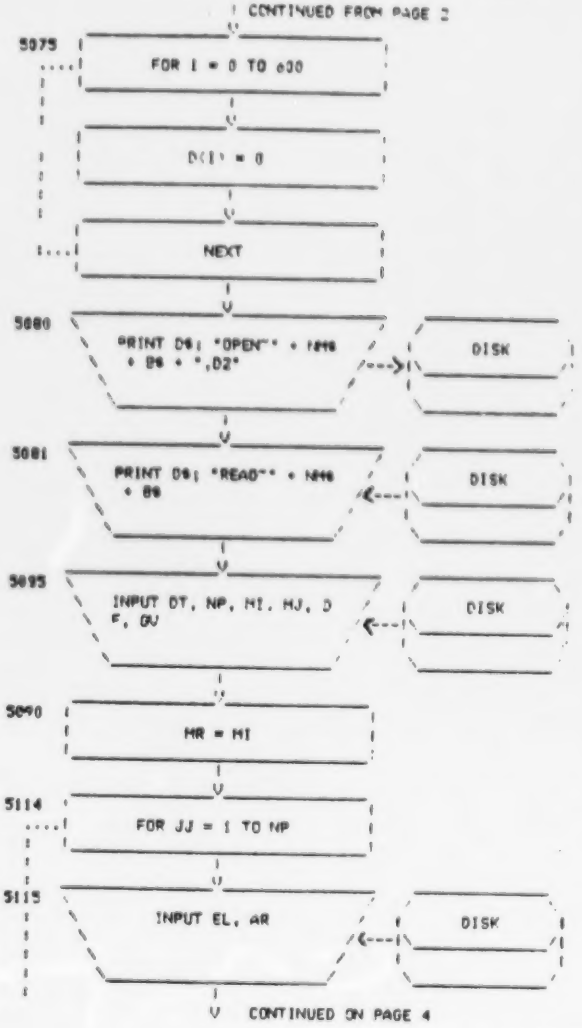
```
12    ONERR GOTO 5500
13    DIM D(601)
1520  EN = PEEK(222)
5000  REM   THIS PROGRAM READS A FILE WRITTEN BY VISTASUMMARY AND
      REWRITES IT FOR SCIPLOT
5017  NM$ = "SUMMARY"+"0"
5018  R0 = 0
    : R1 = 0
    : R2 = 0
    : MR = 0
    : CT = 0
5020  INPUT "WERE"FID(0),"FPD"(2)"OR"BOTH"DETECTORS"(1)"USED?";R0
5025  INPUT "WERE"BOTH"CELLS"IN"USE?;NO=0,YES=1"~~~~~~~~~~~~~~~~";R1
5040  INPUT "DO"YOU"WISH"FULL"OUTPUT;NO=0"YES=1"~~~~~~~~~~~~~~~~";R3
5043  IF R0 = 2
        THEN CT = 1
5045  IF CT = 1
        GOTO 5060
5050  B$ = "1"
5055  GOTO 5065
5060  B$ = "2"
5065  D$ = CHR$(4)
5070  JI = 0
5075        FOR I = 0 TO 600
          : D(I) = 0
          : NEXT
5080  PRINT D$;"OPEN"+ NM$ + B$ + ",D2"
5081  PRINT D$;"READ"+ NM$ + B$
5085  INPUT DT, NP, MI, MJ, DF, GV
5090  MR = MI
5114        FOR JJ = 1 TO NP
5115        INPUT EL, AR
5120        IF R2 = 1
              GOTO 5145
5125        JI = JI + 1
5130        D(JI) = EL
5135        JI = JI + 1
5140      D(JI) =(AR) /(DF * GV)
5145        NEXT JJ
5155  IF R2 = 0
        GOTO 5200
5160  JI = 0
5162  IF MR < MJ
        THEN MR = MJ
5165        FOR JJ = 1 TO NP
5170        INPUT EL, AR
5172        JI = JI + 1
5175        D(JI) = EL
5180        JI = JI + 1
5185        D(JI) =(AR) /(DF * GV)
5195        NEXT JJ
5200  PRINT D$;"CLOSE"+ NM$ + B$
5205  D(0) = JI
5210  FI$ = "FIDP"
5211  FP$ = "FPDP"
5212  F0$ = "C0"
```

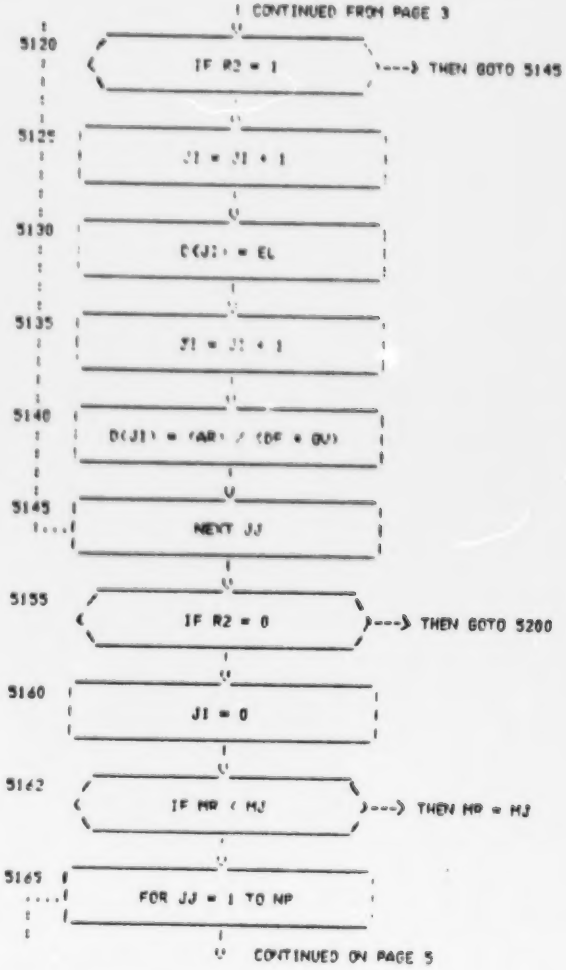


```
5213  FI$ = "C1"
5215  IF CT = 1
        THEN FI$ = FP$
5220  IF R2 = 1
        THEN F0$ = FI$
5230  PRINT D$;"OPEN"+ FI$ + F0$;",D2"
5235  PRINT D$;"WRITE"+ FI$ + F0$
5240        FOR I = 0 TO D(0)
          : PRINT D(I)
          : NEXT
5250  PRINT D$;"CLOSE"+ FI$ + F0$
5315  IF R3 = 0
        GOTO 5340
5319  PRINT D$;"PR#1"
5320  PRINT CHR$(9);"80N"
    : PRINT "TOTAL"ELAPSED"TIME"WAS";D(D(0) + 1);"MINUTES"AND"
      MAXIMUM"CONCENTRATION"WAS";(MR) /(GV * DF);"NG/ML"
5330        FOR JK = 1 TO D(0) STEP 4
5335        PRINT D(JK);
          : POKE 36, 15
          : PRINT D(JK + 1);
          : POKE 36, 30
          : PRINT D(JK + 2);
          : POKE 36, 45
          : PRINT D(JK + 3)
5337        NEXT JK
5338  PRINT "THE"DETECTOR"FACTOR"AND"CELL"VOLUME"ARE";DF, GV
5340  IF R1 = 0
        GOTO 5345
5341  IF R2 = 1
        GOTO 5345
5342  IF R3 = 0
        GOTO 5344
5343  R2 = 1
    : POKE 54, 7
    : POKE 55, 195
    : CALL 1002
    : GOTO 5045
5344  R2 = 1
    : GOTO 5045
5345  R2 = 0
    : IF R0 < > 1
        GOTO 5360
5350  IF CT = 1
        GOTO 5360
5355  CT = 1
    : GOTO 5045
5360  POKE 54, 7
    : POKE 55, 195
    : CALL 1002
    : END
5500  POKE 2043, 72
5510  LN = PEEK(218) + PEEK(219) * 256
5520  EN = PEEK(222)
5530  PRINT "ERROR"CODE:";EN;"IN"LINE"NUMBER:";LN
5540  POKE 2043, 200
5550  END
```

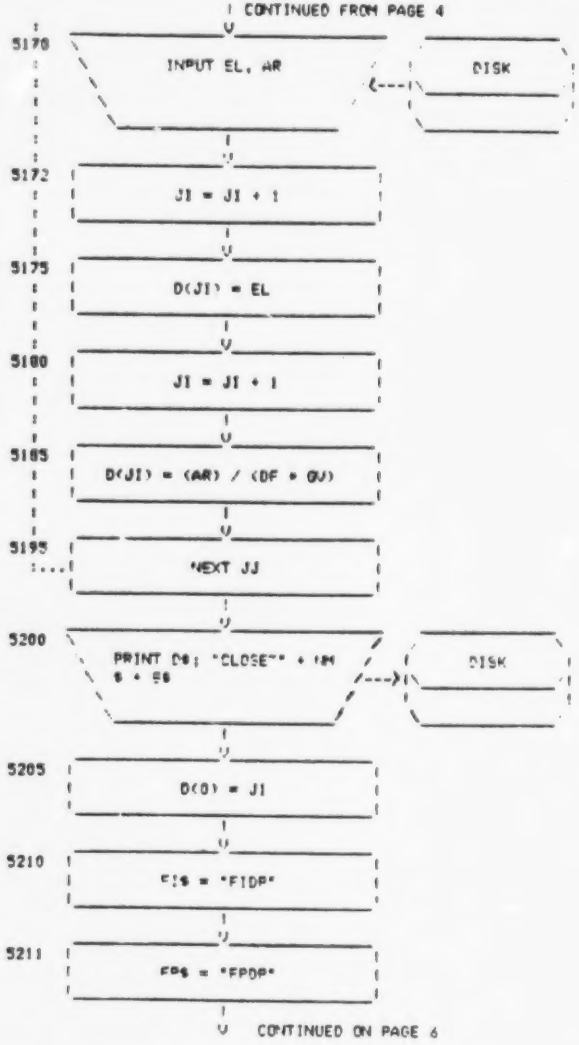

START
12
ONERR GOTO 5500
---> 5500
13
DIM D(601)
1520
EN = PEEK (222)
5000
REM THIS PROGRAM READS A FILE WRITTEN BY
VISTASUMMARY AND REWRITES IT FOR SCIPLOT
5017
N$ = "SUMMARY"+"0"
5018
R0 = 0
R1 = 0
R2 = 0
MR = 0
CT = 0
CONTINUED ON PAGE 2


CONTINUED FROM PAGE 1
5020
INPUT "WERE"FID(0),"FPD
"(2)"OR"BOTH"DETECTORS"
/1)"USED?"; R0
KEYBOARD
5025
INPUT "WERE"BOTH"CELLS"
IN"USE?;NO=0,YES=1"+++++
++++++++++"; R1
KEYBOARD
5040
INPUT "DO"YOU"WISH"FULL
"OUTPUT;NO=0"YES=1"+++++
++++++++++"; R3
KEYBOARD
5043
IF R0 = 2
---> THEN CT = 1
5045
IF CT = 1
---> THEN GOTO 5060
5050
B$ = "1"
5055
GOTO 5065
---> 5065
5060
B$ = "2"
5065
D$ = CHR$ (4)
5070
J1 = 0
CONTINUED ON PAGE 3


! CONTINUED FROM PAGE 2
5075
FOR I = 0 TO 630
D(I) = 0
NEXT
5080
PRINT D#; "OPEN" + NM$ + D$ + ",D2"
DISK
5081
PRINT D#; "READ" + NM$ + D$
DISK
5095
INPUT DT, NP, MI, MJ, DF, GU
DISK
5090
MR = MI
5114
FOR JJ = 1 TO NP
5115
INPUT EL, AR
DISK
CONTINUED ON PAGE 4


! CONTINUED FROM PAGE 3
5120
IF R2 = 1
THEN GOTO 5145
5125
JI = JI + 1
5130
D(JI) = EL
5135
JI = JI + 1
5140
D(JI) = (AR) / (DF * GU)
5145
NEXT JJ
5155
IF R2 = 0
THEN GOTO 5200
5160
JI = 0
5162
IF MR < MJ
THEN MR = MJ
5165
FOR JJ = 1 TO NP
CONTINUED ON PAGE 5

CONTINUED FROM PAGE 4



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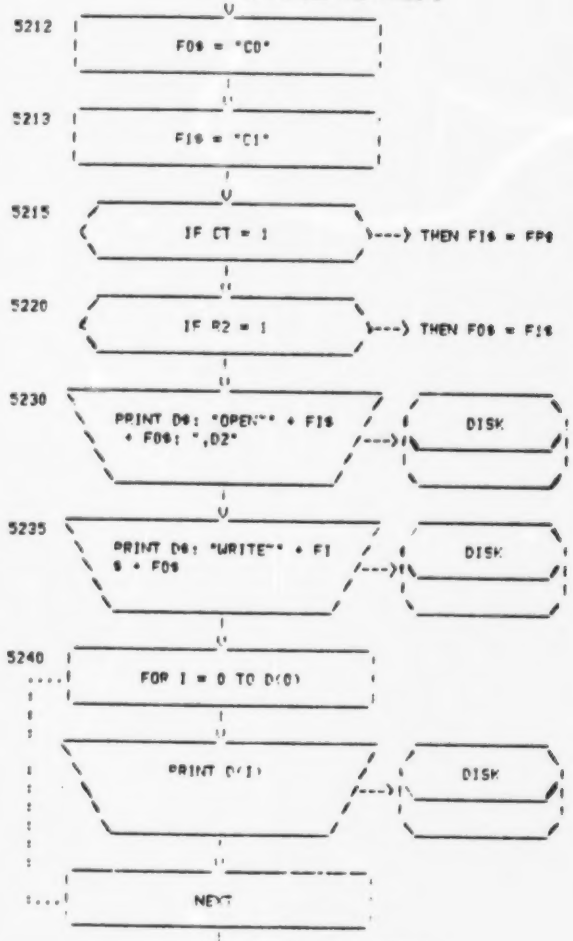
CONTINUED FROM PAGE 5



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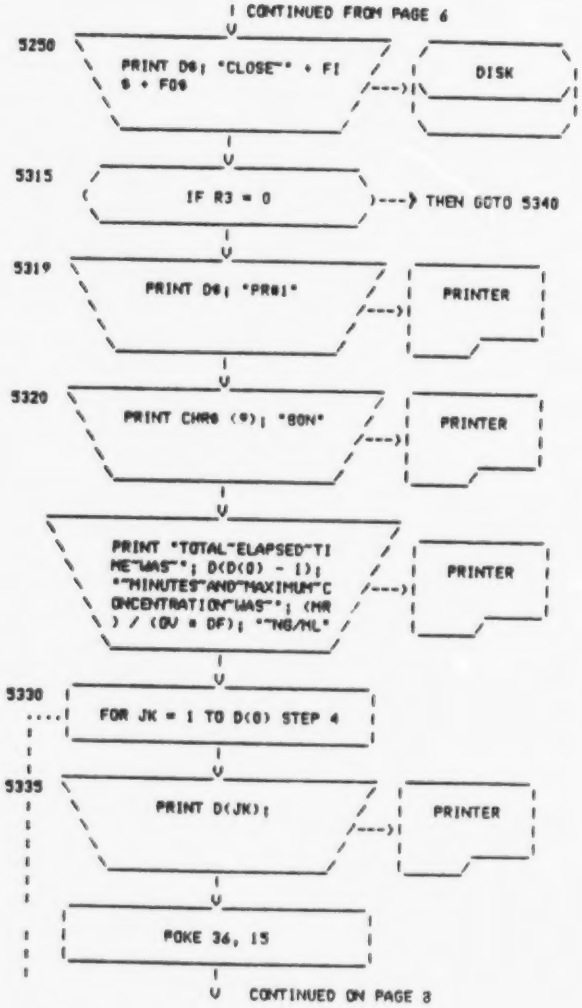
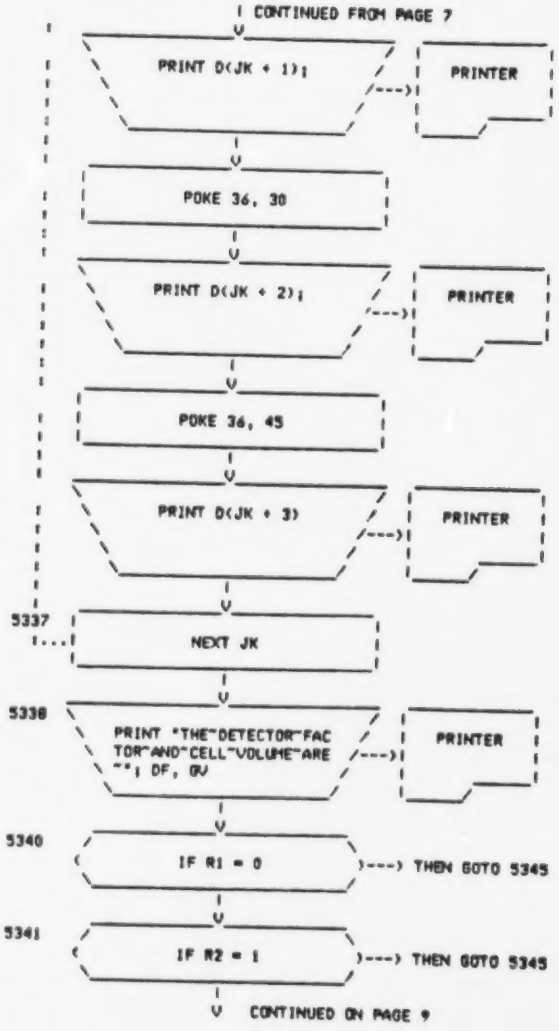
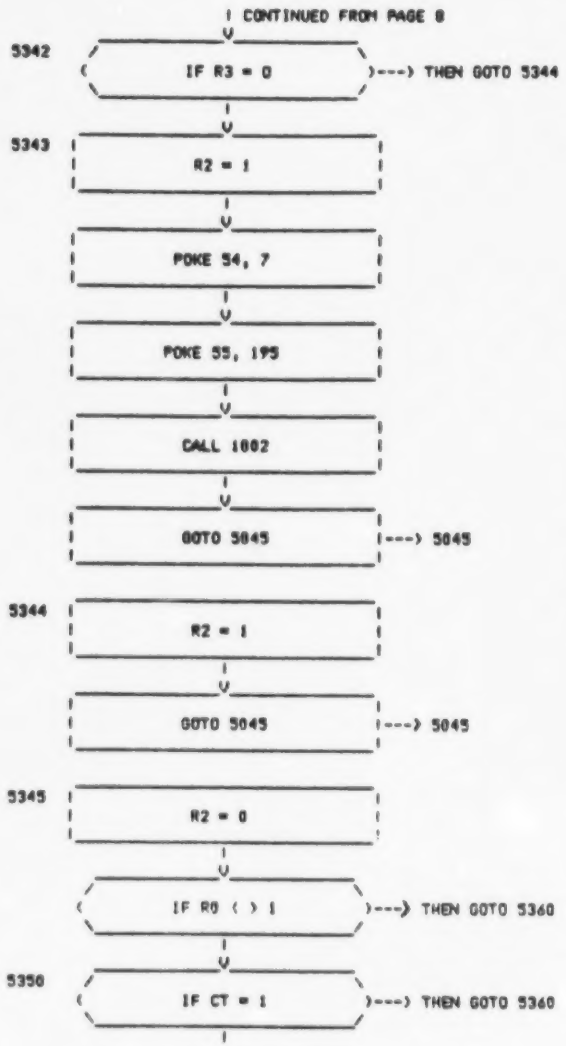
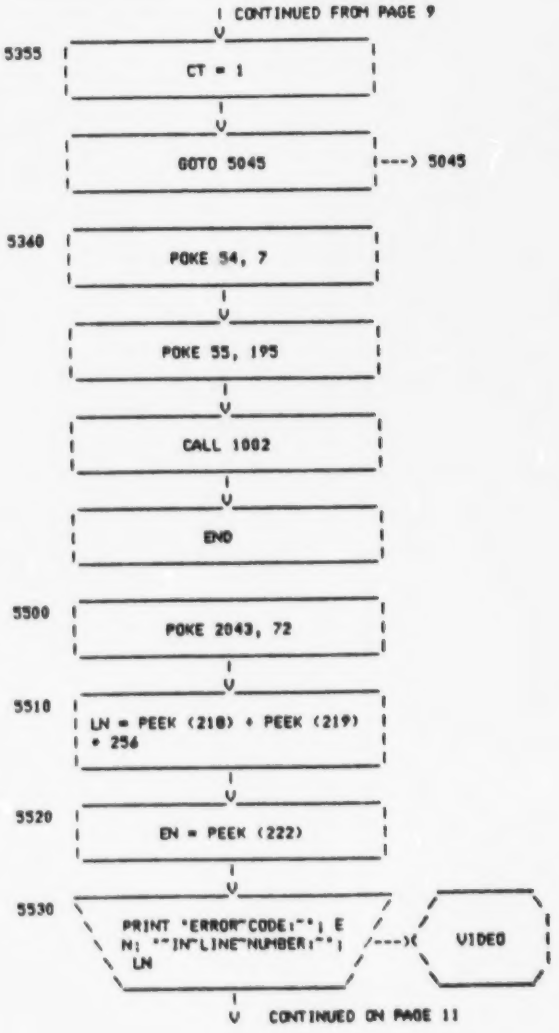


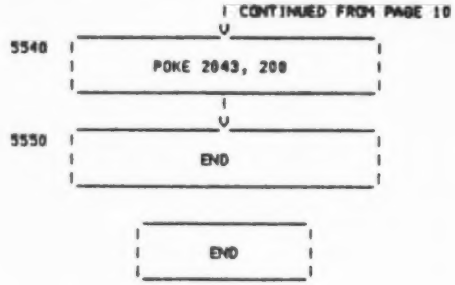


APPENDIX 3. (Cont'd)





APPENDIX 3. (Cont'd)


CONTINUED FROM PAGE 10
5540
POKE 2043, 208
5550
END
END

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An automated system utilizing two Varian gas chromatographs, a Varian 401 Chromatography Data System and an Apple II+ computer has been developed to perform repetitive analysis for Chemical Warfare or other target vapours either penetrating through or desorbing from materials. Single- or simultaneous dual-detector analysis of target vapours in effluent gas streams from one or two vapour sources can be performed by use of a heated multiport gas sampling valve. Software for the storage of vapour analysis results on the stand-alone microcomputer has been developed. As well, programs for post-run selection and storage of quantitative results of specific components based on retention time, output of tabular summaries of the selected component concentration with elapsed time and graphical display and hardcopy of the concentration-elapsed time profiles are described. Subsequent analysis of liquid extracts of the material for residual agent is accomplished on the second dual-detector gas chromatograph equipped with autosampler. The design of a desorption cell for use with the system is also given and an example of the utility of the system employing Malathion is described.

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